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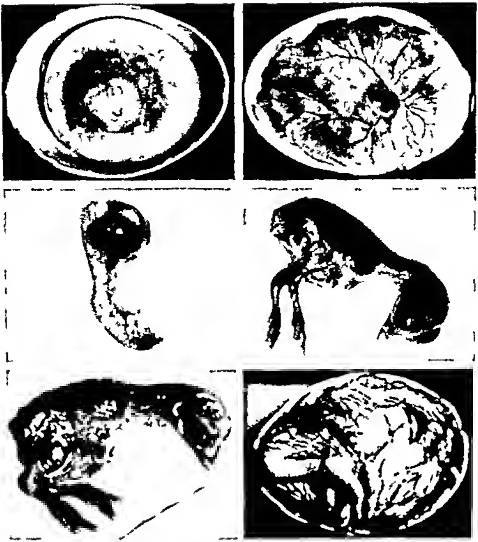
MODERN POULTRY HUSBANDRY



Frontispiece THE DEVELOPMENT OF THE CHICK

1 The egg after 48 hours incubation. The embryo surrounded by the vascular area is clearly visible.

2 *After 96 hours incubation the vascular area extends over the yolk, blood vessels* radiating from the embryo.

3 The huge head and *staring eyes* of the embryo 6 days old.

4 On the twelfth day of incubation eyelids begin to form.

5 On the fourteenth day down covers the body and the beak and eyes are beginning to assume familiar form.

6 The chick on the nineteenth day of incubation immediately prior to hatching showing normal presentation. The rudimentary wing feathers have been parted and the eye opened to show the position of the head. The beak with its horny tip (egg tooth) can be seen above the eye.

Photographs by [illegible]

MODERN POULTRY HUSBANDRY

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Foreword

In the short space of forty years poultry keeping in Great Britain has attained the stature of a great specialized industry with an annual gross output of about £240 million. This has been achieved not merely by an expansion in the number of fowls but also through a progressive and substantial increase in the average output of both eggs and poultry meat, arising through the application of new techniques in breeding, feeding and general management.

The publication of a fifth edition of *Modern Poultry Husbandry* including considerable revision, particularly of economic data, is opportune, for poultry keepers are facing critical times, in which costs of production are rising and commodity prices are declining. There exists, however, a considerable potential for expansion for *per capita* consumption of eggs, and poultry meat still lags behind other countries with a comparable standard of living to our own.

The future will undoubtedly be increasingly competitive, and only truly efficient producers will survive the cold blast of economic reality which lies ahead. This will probably require some form of business integration of all sections of the Poultry Industry in order to achieve maximum efficiency in purchasing, management and marketing.

In no other branch of livestock production has there been such a sustained and general interest on the part of farmers in the results of scientific research, and despite the rapid advances in this field, the more promising results are soon applied in practice.

A comparison of the contents of the first and the present edition of Mr. Robinson's book shows the remarkable changes which have taken place in almost every aspect of poultry husbandry within the last decade. From a farming practice, poultry keeping has become a factory process and requires for

success a similar standard of business acumen and technical competence as with any other modern industry.

The body of knowledge is now so extensive and poultry keeping so specialized that it is a difficult task to prepare an omnibus text-book which is not unwieldy yet escapes the criticisms of omission or lack of balance. The generous comments on previous editions indicate that the author has found the solution to this problem, and it is hoped that the present version will prove just as informative and useful to all who are engaged in poultry husbandry as a career.

H. TEMPERTON

March 1961

Preface

In writing this book the author has endeavoured to convey to the reader some impression of the British poultry industry and to explain the fundamental principles of poultry breeding and production.

The text is based on everyday questions and problems that so commonly arise in management. Necessarily subjects cannot be dealt with in great detail, but it is hoped the information will be of assistance to the poultryman and prospective poultryman.

Progress in the development of the industry noted in previous editions of this work has continued rapidly in recent years. Commercial production in each of its branches has become more specialized. Few enterprises are engaged with all sections of the industry. Breeding, chick production, egg and table production, processing and marketing—each section is largely in specialist hands.

Units are much larger than formerly. Intensive systems are widely applied. The housing of breeding stock under intensive conditions is accepted practice, while many are now rearing pullets in confinement either in deep litter houses, in cages or in larger indoor or outdoor wire-floor rearing units.

An increasing number of breeders and producers house their birds in windowless houses which provide controlled environment. Light patterns are employed to retard or advance sexual maturity and to promote egg production.

Newer systems of breeding involving progeny testing of large groups of families and the mass multiplication of successful strain combinations are now commonplace. They are organized by chick producers, with whom breeders co-operate in carrying out breeding programmes, in many cases under the direction of geneticists. The bulk of commercial chicks is

supplied by companies operating on a vast scale with great financial resources

In this edition material presented in previous editions has been brought up to date Some of the more recent experimental work likely to be of value to the breeder and producer is discussed

Chapter Twenty-one has been almost completely re written to bring estimated costs and returns in line with those currently prevailing

In accordance with the provisions of the Agriculture Act (1947), the average price of eggs is fixed annually at the February Price Review

The price is guaranteed to the British Egg Marketing Board, not to producers For the production year ending March 1962 the average price for first quality eggs is 3s 8 63d per doz (related to a feed price of 23s 5d per cwt) subject to deduction of the Board's expenses, a profit and loss sharing arrangement between the Government and the Board and changes in the price of the standard poultry ration Table poultry is not a Price Review commodity

The author is deeply indebted to Dr Harold Temperton, Vice Principal of Harper Adams Agricultural College and Head of the National Institute of Poultry Husbandry, for reading the typescript of all chapters other than Chapter Twenty, as well as for kindly contributing the Foreword, and to Dr R F Gordon, Director, Houghton Poultry Research Station (formerly Poultry Research Station Animal Health Trust), for reading Chapter Twenty Both made valuable suggestions for the improvement of this work, and the author is grateful to them for their assistance and their continued interest in the book

He wishes to thank Dr R Coles, Chief Poultry Officer, Ministry of Agriculture, Fisheries and Food, for providing data relating to the structure of the industry, the many research workers and poultrymen at home and overseas who have kindly furnished information on subjects of which they have special knowledge, Mr Charles Meekley for drawings, and all who have supplied photographs

LEONARD ROBINSON

April 1961

Contents

Chapter One

The Poultry Industry

SPECIALIZED poultry production on farms and small holdings began after the 1914–18 war Several earlier attempts had been made to keep poultry on a commercial scale, but, with few exceptions, they proved unsuccessful

After the 1914–18 war, however, the price of eggs and table poultry, especially during the winter, was very high, and although food and other costs were also high, there was a considerable margin of profit from well-managed flocks In those days it was a comparatively easy matter to make money from poultry

These boom years coincided with demobilization, and a large number of men returning from the Forces soon found that office and factory life was not congenial after years in the open air Many of them wanted to live and work in the country, and concluded that poultry-keeping offered a solution of their problem Consequently poultry farms, most of them of small acreage, sprang up like mushrooms during the years immediately following 1918 Thus specialized poultry-farming began

It would take too long to tell the full story of the industry between the two world wars Suffice to say that although the margin of profit became narrower, the industry remained relatively prosperous It was the last of the agricultural industries to be affected by the world slump in trade

In the early 1930s, however, egg prices reached a very low level, owing to economic circumstances, and the position was aggravated by large supplies of imported eggs that were dumped on the market It seemed that almost every country in the world could send eggs to us, and so keep down prices Table-poultry prices were similarly affected by the prevailing conditions

In addition to low prices, the poultry producer had to contend with an ever increasing rate of mortality among his flocks As the industry developed, so mortality increased, until

TABLE 1

Number of Poultry in England and Wales and Scotland (in thousands) (Data from Agricultural Returns, Ministry of Agriculture and Fisheries and the Department of Agriculture for Scotland)

Year	Six months and over		Under six months	
	England and Wales	Scotland	England and Wales	Scotland
1929	42 756	2 638	†	3 004
1930	47 900	2,766	†	3 550
1931	52 563	3 129	†	3 948
1932	57,746	3,486	†	3 951
1933	61 171	3 742	†	4 351
1934	26 890	3 830	33 439	4 198
1935	26 632	3 793	31,675	3 995
1936	25 361	3 780	32 381	4 174
1937	24 377	3 619	28 255	3 577
1938	22 914	3 530	29 594	3 850
1939	23 154	3 456	29 758	3 865
1940	25 739	3 814	25 438	3 552
1941	24 763	3 655	15 348	2 466
1942	17 291	3 152	16 678	3 035
1943	13 374	2 923	13 135	2 858
1944	12 973	3 002	15 848	3 162
1945	14 357	3 175	19 453	[illegible]
1946	16 033	3 470	20 157	3 736
1947	17 460	3 840	20 376	3 599
1948	19 596	4 080	28 268	4 652
1949	23 959	4 670	33 033	4 827
1950	28 731	5 007	32 761	[illegible]
1951	28 622	4 912	34 862	[illegible]
1952	27 804	4 733	37 256	4 911
1953	27 956	4 655	36,214	4 856
1954	27 816	4 544	32 577	4 109
1955	27 399	4 361	36 610	4 323
1956	28 603	4 392	39 815	4 597
1957	31 923	4 474	38 746	4 472
1958	32 507	4 35[illegible]	42 709	[illegible]
1959	35 318	4 23[illegible]	47 [illegible]	4 51[illegible]
1960	34 359	4 008	45 753	4 171

June 1960 Returns for England and Wales show only totals of 29 million young fowls for breeding or laying, 19½ million for broiler production and three million for other table poultry

† Not recorded separately

it became a burden so heavy that many could not shoulder it. The position became so critical that in 1935 the Minister of Agriculture appointed a committee "to consider the present methods of supply and distribution of hatching eggs, day old chicks and breeding stock in Great Britain, both generally and with particular reference to the reduction of poultry

mortality; and to make recommendations for the improvement of those methods ".

The picture of rising mortality is clearly revealed in the table below, from the *Report of the Poultry Technical Committee of Great Britain.*

It must not be assumed, however, that heavy mortality was the only cause of people giving up their poultry-farms. Long before losses among the flocks of this country as a whole became serious there were numerous failures in the ranks of poultry-farmers. These were almost entirely due to lack of experience and/or capital.

TABLE 2

Percentage Mortality in Four Large Laying Trials

Year	Trial				Year	Trial			
	1	2	3	4		1	2	3	4
	Per cent	Per cent	Per cent	Per cent		Per cent	Per cent	Per cent	Per cent
1923–24	5·2	6·1	—	—	1930–31	7·9	10·7	12·3	9·0
1924–25	5·0	5·4	3·4	7·5	1931–32	10·8	15·5	15·4	10·0
1925–26	5·2	5·2	6·1	7·2	1932–33	11·2	14·8	15·4	9·6
1926–27	4·1	6·6	9·6	7·0	1933–34	13·5	16·4	17·8	15·2
1927–28	5·3	7·3	7·1	6·5	1934–35	14·8	20·0	23·1	17·3
1928–29	6·8	7·1	7·8	5·5	1935–36	16·8	20·2	17·9	19·6
1929–30	7·8	8·8	13·8	8·3	1936–37	17·5	21·3	21·2	19·6

A large number of people who had no experience of the work took up poultry-farming. They believed that the job was a simple one, that it was only a question of keeping, say, 800–1,000 layers, and their living was assured. They quickly learned that it was not so simple—that, in fact, poultry-farming demanded great skill that could be acquired only by experience. They soon found that things did not follow according to plans drawn up with more enthusiasm than wisdom. Hence, the first major set-back, such as a poor rearing season, commonly involved them in financial difficulties from which they were unable to recover.

The rise in mortality occurred years after the rush to get into poultry-farming abated, after many with insufficient capital, experience and adaptability had sold their farms, but the seeds of ill health in the popular utility strains had been sown.

Looking back to these early years of the poultry industry, it seems extraordinary not that so many people failed, but that so many succeeded.

Lack of experience in breeding was the cause of the deterioration in the health of the birds. The cumulative effects of unsound breeding began to show themselves in 1930–31, and reached their peak in 1937.

Before mortality became serious, breeding was largely a matter of selection for high egg production. That was the principal objective of the breeder. Accordingly, he based his selection on *trap-nest records* and considered other characters of minor importance—if he considered them at all. Generally speaking, the birds with the highest records were placed in the "special pens", and stock from these pens fetched the highest prices because the public demanded spectacular records and were prepared to pay for them.

Few breeders in the days of low mortality considered the health factor. They bred from precocious pullets that lacked body-size and stamina. They bred from birds that laid thin-shelled eggs, and from birds that produced eggs of low hatchability—one indication of lack of vigour.

Moreover, during these years the hatchery section of the poultry industry was establishing itself. Large profits could be made from the sale of day-old chicks, and in order to secure them people with no knowledge of poultry and no interest in the welfare of the industry installed mammoth incubators, and then proceeded to purchase hatching eggs from any source in order to operate the machines at their maximum capacity.

They were the black sheep of the hatchery movement.

The high death rate that followed was the direct result of the unsound methods of selection of breeding stock and the policy of mass production without regard to the quality of the stock. It was not due to intensive methods of rearing, dry-mash feeding or other factors to which it has been attributed by people who should know better. The trouble arose because breeders, in their anxiety to produce record layers, failed to realize that good health is of primary importance. Everything depends on it. Instead of putting health first when selecting their stock, they attached undue value to the trap-nest record, and consequently they eventually bred birds that lacked the

stamina to give expression to the very factor for which they were selected. Nature stepped in and called a halt to a method of selection that produced an unbalanced bird.

When circumstances compelled breeders to alter their views on selection many took a directly opposite course by refusing to breed from birds with high egg records. Some even advocated the scrapping of trap-nests. In other words, they attributed high mortality to high production.

There is no evidence to show that these two factors are correlated; on the contrary, it can be argued that a bird laying from 250 to 300 eggs in a year must possess an abundance of vigour to withstand the strain of heavy production.

Over twenty years ago Crowther showed that in the 1934–35 Harper Adams Laying Trials, when mortality was 16·8 per cent, compared with 3 or 4 per cent in the twenties, egg production was the lowest recorded for ten years. This suggests a possible connection between high production and high mortality.

He found no support, however, for the view that higher mortality could be attributed to higher production, and suggested that the cause should be sought elsewhere.

Hays (1952) compared the breeding performances of 300-egg hens with their sisters below 300 eggs. His investigations showed that the average egg production of the daughters of 300-egg hens was superior to that of the daughters of their full sisters and that mortality among daughters of 300-egg hens was lower than among daughters of hens with records of less than 300 eggs.

It is quite certain that high fecundity is not opposed to stamina. Selection for the former is detrimental to the health of the stock only when it is given primary consideration, when birds are selected for the breeding-pen on their trap-nest records, without regard to other characteristics.

Fortunately, the importance of the health factor is now widely recognized, and our leading breeders are applying the lessons long experience has taught them. They are putting health in the forefront of their breeding programme—not only the health of the individual, but also of the family.

Selection is based on family and individual performance. The best families are selected, and finally the best individual birds within superior families.

This is the modern approach to breeding problems; it is the basis of stock improvement, families being finally assessed by collateral performance (*i.e.*, sister and brother and half-sister and half-brother records) and/or by the quality of the progeny they produce.

Our leading strains are more vigorous than they were in the 1930s. Better methods of selection have reduced average mortality, although it is not down to the level of the early 1920s, and it is doubtful whether such a level is a practical objective having regard to health hazards in commercial production.

Some indication of the extent of the improvement in the health of the stock is seen in reports of laying tests.

TABLE 3

Percentage Mortality at the National Poultry Tests

1938–39	16·18	1949–50	9·38
1939–40	14·23	1950–51	9·11
1940–41	14·13	1951–52	9·85
1941–42	12·35	1952–53	9·84
1942–43	12·06	1953–54	9·03
1943–44	10·52	1954–55	9·12
1944–45	11·26	1955–56	8·61
1945–46	10·22	1956–57	9·15
1946–47	14·01	1957–58	8·79
1947–48	10·80	1958–59	12·06
1948–49	8·24		

That the improvement in viability was not secured at the cost of egg production is shown in the following table:—

TABLE 4

Average Egg Production per Bird Hen-housed at the National Poultry Tests

1937–38	169·03	1948–49	187·08
1938–39	169·51	1949–50	193·18
1939–40	165·02	1950–51	197·28
1940–41	164·98	1951–52	198·31
1941–42	178·62	1952–53	191·37
1942–43	181·26	1953–54	193·21
1943–44	179·74	1954–55	198·65
1944–45	184·70	1955–56	200·24
1945–46	182·14	1956–57	205·72
1946–47	178·46	1957–58	[illegible]
1947–48	191·40	1958–59	[illegible]

It is difficult to explain the rise in mortality in 1958–59. There was a sharp increase in losses towards the end of the test year, but mortality in sections other than the breed sections (to which the above table relates) at the National Poultry Tests showed little change.

In the 1959/60 test mortality was 8·07 per cent and average production reached the record level of 220·39 eggs per bird.

For the 1958 entry at the official Progeny Testing Stations of the Poultry Stock Improvement Plan the death rate was 13·9 per cent.

Gordon (1960) [1] estimated that under commercial conditions average mortality from day-old to the end of the first laying season was in the region of 22–25 per cent.

Coles (1955) [2] calculated that with the present poultry population of the United Kingdom having an output of £180 million an annual net loss through mortality of £10 million was sustained and that such a death rate reduced the potential egg output of the industry by approximately a further £20 million.

In addition, serious losses occur in incubation. Coles and Underwood (1954),[3] in a survey embracing 200 breeding farms and a number of hatcheries, found that from 30 to 35 per cent of all eggs set failed to hatch. This represents an annual loss of more than £1 million per annum.

These losses cannot be attributed to breeding errors alone; there are many other factors at work, but there is no doubt that a great deal can be done to improve the health of the stock by careful selection on a family basis.

The popular conception that poultry-keeping is an unimportant side-line of British agriculture is completely erroneous. The annual gross value of home-produced eggs and poultry is now estimated[1] at £234 million or 16 per cent of the annual gross value of the whole of the agricultural industry.

The following data from Annual Review and Determination of Guarantees 1961 (Cmnd. 1311) show the value of agricultural products:

[1] Personal communication
[2] *The British Veterinary Journal*, Vol III, pp 235–252
[3] *Empire Journal of Experimental Agriculture*, Vol XXII, pp 281–292

TABLE 5

Farm Sales of Agricultural Products

	£ million.	
	1959-60 (revised).	1960-61 (forecast).
Milk and products . . .	343½	349½
Fatstock . .	431½	435
Eggs and poultry . . .	234	251
Farm crops	265	258
Horticultural products .	142½	133
Other	50½	51½

The aggregate value of fatstock far exceeds that of eggs and poultry, but fatstock includes beef, veal, mutton, lamb and pig-meat. Similarly, all crops are grouped under heading of farm crops.

The estimated breakdown of financial returns from eggs and poultry in 1959-60 and 1960-61 is shown in Table 6.

TABLE 6

Estimated Financial Returns: Eggs and Poultry *

	£ million.	
	1959-60.	1960-61 (forecast).
Eggs	194	201
Poultry	40	50

* Coles Personal communication.

Few realize that eggs and poultry represent so large a proportion of the total value of the annual agricultural and horticultural output of this country.

This great industry mainly comprises a large number of small flocks kept on general farms. Many of these flocks follow the traditional pattern—that is to say, they are regarded as the perquisite of the farmer's wife, who earns a little "pin-money" by looking after them.

If accurate and complete costs of maintaining such flocks were recorded they would undoubtedly show that most of them are unprofitable, but since no charge is made for family labour and little, if any, for feeding-stuffs obtained from the

farm's granary, they are a worthwhile proposition at least for the farmer's wife, if not for the nation.

Many general farmers, however, have taken their poultry from the pin-money class. While the flock is managed by family labour and subsists largely on home-grown foods, it has been increased to about 300–500 birds. In these circumstances the flocks are regarded as an integral part of the farm's livestock, they are given systematic attention and are expected to pay their way.

A relatively small number of farmers have developed poultry-keeping on a large scale. They have established flocks of several thousand birds, and of course employ a skilled staff to look after them. Where very large farms are involved a number of poultry units are sometimes maintained, each in charge of an experienced manager, and a competitive spirit is introduced by paying a bonus on output or on the annual profit.

Coles (1960),[1] in a study of the British poultry industry based on the agricultural returns of June 1957, showed that of the 367,857 holdings in England and Wales, 255,022 carried adult fowl, which were distributed as follows:—

TABLE 7

Distribution of Adult Birds, England and Wales (1957)
(Coles 1960 [1])

No of adult birds	Percentage of holdings
1–99	63 37
100–499	33 57
500–999	1 73
Over 1,000	1 33

His estimate of the percentage of eggs produced in 1959 by flocks graded according to size is shown in Table 8.

Coles (1949) [2] estimated that holdings with up to 100 birds contributed 35 per cent of eggs produced; holdings with 100–500 birds, 50 per cent; holdings with over 500 birds, 15 per cent.

Thus it will be seen that in recent years there has been a

[1] *Development of the Poultry Industry in England and Wales 1945–59*
[2] *Agriculture*, Vol 56, p 332

TABLE 8

Percentage of Eggs Produced by Flocks Graded According to Size (Coles 1960 [1])

No. of birds	Percentage of eggs produced
1–99	18
100–499	51
500–999	14
Above 1,000	17

marked change in the pattern of the industry. The number of small flocks has declined, while the number of large flocks has increased.

A decade ago flocks over 500 birds contributed about 15 per cent of the eggs produced; to-day they produce about 31 per cent.

The trend towards larger flocks continues, indeed some holdings now carry more than 10,000 laying stock.

Moreover, there has been a major change in the methods of housing towards intensivism.

A survey of the poultry industry in 1951 showed that about 10 per cent of adult birds were kept in batteries and 3–4 per cent on deep litter.

Coles (1954) estimated that from the beginning of 1948 to the end of 1953 approximately 3½ million laying battery cages were sold in this country.

TABLE 9

Estimated Numbers of Birds (Millions) Housed on Different Systems in 1961. (Coles [1])

Battery cages	Deep litter wire and slatted floors	Range
14 (40%)	10·5 (30%)	10·5 (30%)

Figures in brackets are percentages of total laying birds in England and Wales

While the industry has been turning to intensive methods of egg production, table-poultry production has also developed on intensive lines. American methods of broiler production, by

[1] Personal communication.

which large groups of chicks are reared intensively to ten to eleven weeks of age, have been adopted in this country.

The growth of this section of the industry has been rapid, indeed spectacular. Owing to rationing of feeding-stuffs specialized table-poultry production was abandoned in 1939 When, however, food supplies once more became abundant the scope for the mass production of table poultry on the American broiler system was recognized, and large plants have been erected for the purpose

The broiler industry has become one of major economic importance, it has become a specialized industry within the framework of the poultry industry Its output is very large and continues to increase rapidly

In 1959 60 it was estimated[1] that some 220 million chicks were hatched in England and Wales Of these approximately 65 million were pullet chicks reared for egg production A further 100 million of both sexes were sold for broiler production and the remainder (cockerel chicks) slaughtered at day-old.

With the expansion of table-poultry production attention has been paid to large-scale processing Specialized packing stations have been established, frequently by egg-packing stations or by groups of producers, the birds being collected alive from the farm, killed, plucked and packed at the stations and finally delivered to wholesalers or retailers

Scope for the Development of the Poultry Industry. Notwithstanding the rapid increase in egg and table-poultry production of recent years, there is wide scope for the further development of the poultry industry

The number of adult birds in the country has risen substantially since the low level of 1943–44, and the average egg yield per bird has also increased Twenty years or so ago average egg production was in the region of 150 eggs per bird, to-day on well managed plants employing intensive methods of housing for laying stock it is about 200

Coles (1959)[2] computed that average egg production per bird for the four main systems of poultry keeping was as follows batteries 220, deep-litter 190–200, folds 180, free range 160 170

[1] Coles Personal communication
[2] Personal communication

At the present time the industry is providing the consumer with about 229 eggs per annum of a total estimated annual *per capita* consumption of 234 (1958) Thus of the total *per capita* consumption only five eggs are imported

This level of consumption is far below that of the United States, where it was 349 in 1958, which in fact was 40 eggs lower than for 1950 [1]

The high level of consumption in the United States seems to have been secured by well planned publicity by the Poultry and Egg National Board (P E N B) The Board was established to promote sales by press advertising, window displays and the distribution of attractively printed literature in which there are recipes for egg and poultry dishes The Board is supported financially by all sections of the poultry industry—producers, processors, feed compounders and others

In this country efforts were made to follow the American example An organization was set up for the purpose of increasing the consumption of eggs and poultry Unfortunately it did not receive adequate support, and consequently its efforts were largely abortive

However, when the British Egg Marketing Board assumed control of egg marketing in July 1957 it was possible for the first time to undertake a national advertising campaign on an effective scale

A levy on producers of ½*d* per dozen eggs provided a fund from which over £892 000 was disbursed in 1959 60 for advertising publicity and public relations

With an annual consumption of 349 eggs *per capita* in 1958 the United States had about 301 million hens and pullets [1] Average rate of lay was 201 eggs per bird, compared with 198 in 1957

The consumption of table poultry in the United States was about 36 lb per head In Britain (1959) it was about 9 8 lb, including imported supplies or nearly twice the estimated consumption in 1951

The increase in poultry consumption is due largely to the expansion of the broiler industry

In 1959 The British Broiler Growers Association set up the Chicken Information Council which is now responsible for all

[1] U S Dept of Agric Agricultural Marketing Service [illegible]

the Association's publicity on behalf of the table chicken industry

If this country is to equal or even to approach the same standard of consumption of home produced eggs and poultry as in the United States, it would mean building up the industry to a point at which it could supply everyone with a new-laid egg a day Thus it would be necessary to maintain on general farms and specialist holdings about 80 million layers and to produce about 400 million table birds annually

Expansion of the industry to this extent is feasible, indeed, some forecast that the output of broilers will exceed 400 million per annum in the course of a few years

Increasing egg consumption, however, is proving more difficult At certain periods in the spring high production has not been met by proportionately high consumption, and it was necessary for the Egg Marketing Board to take off the shell-egg market a substantial quantity for the production of frozen egg in 1958, 1959 and 1960

No doubt publicity, improved marketing and packaging of eggs for the retail trade will raise the level of consumption, but progress is likely to be slow Experience has shown that the habits of the consumer are not readily changed

Egg sales are handicapped by the wide fluctuation in seasonal prices and the very marked price differential between egg grades, particularly in the autumn and early winter months, when the supply of small eggs is abundant

Efforts are now being made to secure more uniform production throughout the year This should not be difficult in view of the widespread application of intensive systems of housing laying stock, although it will entail greater co operation among producers than has prevailed hitherto

The formation of groups of egg producers to co ordinate production may contribute to the solution of this problem Group production is essential to ensure the stability of the market in the broiler industry, it may play an equally essential part in the egg industry

In common with other commercial activities, the prosperity of the poultry industry is linked with that of the country as a whole, but so far as can be foreseen there seems no reason to believe that the efficient egg and table poultry producer will

not continue to secure a fair return for his labour and capital

This, of course, is subject to a number of conditions, among them being ability of the breeder to maintain a high health standard and high productivity in his strains

The need for effective control of stock distribution was recognized by the Poultry Technical Committee This Committee made certain recommendations designed to safeguard the health of the stock, and to prevent ignorant buyers being exploited by unscrupulous breeders and dealers, who do not hesitate to sell inferior, weakly and often diseased birds, provided they can do so with profit to themselves

The Committee's recommendations were incorporated in the Poultry Industry Bill presented to Parliament in 1938 This Bill was not placed on the statute book

The clauses designed "to secure improvement in the health and quality of live poultry" may be summarized as follows —

Clause 1 *Provides for the setting up of a Poultry Commission* that will have the function of keeping under review matters relating to the maintenance and improvement of the health and quality of poultry stock and the production and consumption of poultry and poultry products

Clauses 2 and 3 provide for the registration of persons carrying on the business of supplying fowls not intended for immediate slaughter or the business of supplying fowls' eggs for hatching The Commission will be empowered to make regulations for preventing the use of unsuitable fowls for breeding purposes and for requiring the notification of disease

Clause 3 would enable the Commission to prohibit the distribution of fowls or fowls' eggs for hatching from premises on which disease exists or where the breeding stock is obviously unsuitable

Clauses 4 and 5 require the Commission to prepare voluntary accreditation schemes for breeders of fowls and for hatcheries The standards required for accreditation will be higher in certain respects than those required of other breeders and hatcheries The accreditation scheme may provide for the payment of premiums out of Exchequer funds

Clause 6 This defines the constitution of a Stock Improvement Advisory Committee,[1] consisting of members representative of the various interests concerned, together with not more than four additional members appointed by the Ministers The duties of the Committee will be to advise and assist the

Commission in the discharge of its functions in relation to stock improvement.

The need to safeguard the health of the birds is no less to-day than it was in 1938. The great majority of breeders and hatcherymen are fully aware of their responsibility in this respect. Nevertheless, there are some who disregard health in order to produce stock as cheaply as possible.

The buyer should exercise the greatest care in the selection of his source of stock. If he is in doubt guidance can be obtained from his County Poultry Advisory Officer, and from members of the advisory staffs of many leading poultry food compounders.

At the Hot Springs Conference (1943), when representatives of many nations discussed world food problems, they agreed that countries should produce the food for which their soil and climate are best suited, and this, as far as this country is concerned, means milk, eggs, fruit and vegetables.

The British Government accepted the "nutritional policy" formulated at the Hot Springs Conference, and have undertaken to encourage agricultural production in accordance with this policy. Whatever steps the Government may take to assist the home producer, however, the industry cannot fulfil its place in the economy of the nation unless the health and vigour of the stock are maintained and if possible improved.

Poultry Stock Improvement Plan. In 1932 the Ministry of Agriculture introduced the Accredited Breeders' Scheme, designed to effect stock improvement. This scheme, while admirable in its purpose, is entirely voluntary, and it must be stated that it did not receive the support it deserved.

During the late war, when accredited breeders were allowed supplementary rations for approved stock, a great many breeders accepted accreditation; indeed, many could not have remained in business had they been unable to secure the additional rations to which they were entitled under war-time regulations.

There is no doubt that circumstances gave an impetus to the scheme, and thus brought a large number of breeders into it who otherwise would have remained outside. Even with the

[1] A Poultry (Stock Improvement) Advisory Committee was appointed in January, 1945

strong inducement to accept the scheme offered in war-time, a number of well-known breeders would not become accredited

In 1948 the scheme became part of a wider one—the Poultry Stock Improvement Plan (P S I P) of the Ministry of Agriculture and Fisheries

At one time the plan provided a Breeders' Grade for egg production, Breeder's Grade for table-poultry production, a Commercial Grade for egg production and a section for Accredited Hatcheries, but it has since been made more comprehensive

The most striking innovation was made in 1956–57, when an Accredited Breeders' Grade for egg production (Class A) was introduced This entails taking a random sample of the breeder's stock and submitting it to a progeny test at one of the Ministry's Testing Stations In this class the breeder provides a random sample of 105 eggs They are hatched and the chicks are reared at the station Random sampling is carried out by the Ministry's Poultry Advisory Officers From each entry a random sample of 15 pullets is retained for testing

For each batch of 105 eggs submitted, the breeder later supplies two cockerels of the same breed for mating with the pullets

The following are brief details of the Poultry Stock Improvement Plan for 1960-61 —

(1) *The Accredited Section*

8 This section applies to poultry breeders commercial stock suppliers (including hatchery suppliers) and hatcheries Provision is made for breeders and producers of stock for egg production and of stock for table poultry production They may apply for accreditation in one or more grades The Breeders' Grade is for the suppliers of pedigree foundation breeding stock for egg production, the Commercial Stock Suppliers' Grade is for those who supply pure-breds, first crosses, multiple crosses or hybrid stock for commercial egg production or stock for commercial table poultry production whether for rearing or for improving strains for table poultry production

9 Details of the requirements of membership of each sub-division of the section are given in the regulations The sub-divisions are broadly as follows —

(a) *Breeders' Grade Egg Production (Elite) Class A*
Breeders in this class are required to take part in official tests to determine whether their stock and the female progeny of

that stock can demonstrate agreed minimum standards of performance

(b) *Breeder's Grade Egg Production (Fowls) Class B*
Breeders' Grade Egg Production (Ducks)
Breeders in these two classes must show by trapping records that the performance of female birds during their first laying year is up to specified standards The performance records of the families of both male and female stock must also satisfy the Ministry

(c) *Commercial Stock Suppliers' Grade Egg Production*
Commercial Stock Suppliers' Grade Table Poultry Production
In these grades good healthy stock is required, with low mortality, mated to produce pure-breds, first crosses or multiple crosses, there is provision for hybrids for egg production Where stock is accredited for egg production, the Ministry has to be satisfied with the flock laying records Where stock is accredited for table poultry production, the Ministry has to be satisfied that matings are designed to produce birds with satisfactory table poultry characteristics The Table Poultry Production Section has been revised and Breeders' Grade no longer applies to table poultry

(d) *Accredited Hatcheries* are required to receive eggs only from accredited poultry stations and to satisfy the Ministry with regard to standards of hygiene and condition of the buildings and equipment

(2) *The Standard Bred Section*

10 This section is for breeders who distribute standard bred breeds and varieties of fowls, ducks, turkeys, geese and ornamental fowl It is of interest mainly to those concerned with the exhibition side of poultry keeping

Under the above revised regulations the Approved Section which formerly provided for hatcheries working in close co-operation with poultry farmers (approved hatchery suppliers) is merged with the Accredited Section

Breeder's Grade Class B will terminate on 30th September 1961. After that date membership of Breeders Grade (Egg Production) for fowls will be limited to breeders taking part in the official progeny tests

Copies of the Ministry's regulations of the Poultry Stock Improvement Plan may be obtained from the Ministry of Agriculture, Fisheries and Food, Eggs and Poultry Branch, Whitehall Place, London, S W 1

Hatcheries It is estimated that over 90 per cent of all chicks

produced in the U S A come from commercial hatcheries The proportion so hatched in this country is said to be in the region of 75 per cent

In its early days the reputation of the hatchery movement suffered as the result of the activities of a small minority of people, who saw in the hatchery an opportunity of exploiting the poultry man Now, however, the majority of the hatcheries are giving the commercial producer the class of stock he requires and the service he requires This is shown by the growth of this section of the industry, especially in recent years

At one time it was customary for egg producers to breed their replacement stock Today it is exceptional for them to do so The practice of purchasing day old chicks or growing stock from breeders and hatcheries has become general for the reason that it is more profitable than maintaining flocks of breeders at home and undertaking all the work associated with this phase of production

An ever increasing proportion of breeders are now co operating with hatcheries instead of working independently Thus the breeder can devote his whole time to his birds, while the hatchery becomes in effect his sales organization

The average hatchery sets a high standard for the stock, and in this way plays an important part in effecting stock improvement

Some of the larger hatcheries maintain their own breeding flocks, and have instituted a programme of family breeding with the primary object of up grading the stock of the supplying farms

Other hatcheries specialize in the production of hybrids They operate large scale and complex breeding schemes and enlist the help of selected poultry farmers, who undertake the multiplication of successful matings eggs being sent to the hatchery for the production of the commercial hybrid chick

Selected poultry farmers also undertake stock testing for hatcheries Thus hatchery stock is tested at many different locations and under different systems of management

Certain hatcheries specialize in the production of broiler chicks These hatcheries, which are associated with groups of broiler producers have control of the breeding stock and select the birds for the characters required in table chickens

The standard of the average hatchery chick has improved considerably over the years, and competition among hatchery proprietors will ensure that it will remain high.

As in the United States, there is a tendency for hatcheries to become larger and fewer, and it would seem that in time the bulk of the hatchery business is likely to be in the hands of a comparatively few firms.

Chapter Two

The Poultry-farm

THE *Personal Factor.* "Can I make a living from poultry-farming?" That is the question commonly asked by those who contemplate entering the industry. It reveals ignorance of the elements of the subject, because poultry-farming is essentially a business proposition in which money may be made or lost, as in any other business.

It is impossible to give an unqualified reply to the question, for the answer depends on many factors, known and unknown, the most important of unknown factors being the personal one.

Poultry-farming is essentially a personal job. There can be few businesses into which the personal factor enters so largely, few businesses demanding greater attention to detail or making greater calls on one's time, particularly during the early years, while the farm is being established.

It is perhaps unfortunate that, to the uninitiated, poultry-farming appears to be simply delightful and delightfully simple. It is not so. On the contrary, it is most complex, for the poultry-farmer must grapple with the problems common to all commercial undertakings, and, in addition, he has to deal with livestock and to accept the risks associated with it.

Poultry-farming is not an easy means of earning a living. Until one has succeeded in building up a farm of considerable size or establishing a reputation as a pedigree-breeder, and can therefore afford to employ a competent manager, there are few opportunities for relaxation, and the job requires attention every day of the year. It is, however, difficult to establish any business to-day: indeed, if it were not, thousands of people would rush into it, competition would soon become keen and only the most competent would survive. That is the way of the commercial world.

The man who is looking for a life of ease should not invest in a poultry-farm, for he will assuredly lose his money. If,

however, he is prepared to work hard, if he is a real lover of a country life, and has, or is prepared to acquire, what is commonly known as "stock sense", then, given adequate capital, he should be able to earn a living. When that stage is reached he will find an abundance of scope for increasing his income.

To the man of the right type, poultry-farming offers immense possibilities. It is not a business in which fortunes are made, but a fair living can be secured, and one can enjoy that sense of freedom denied to those who earn their livelihood in factories and offices. In poultry-farming a man holds his destiny in his own hands.

Anyone who contemplates poultry-farming should first assure himself that he enjoys a country life. Many people only *think* they do. They base their opinion on their impression of the countryside during the summer months. They do not consider the long winter nights, the unlighted roads, the wind, the rain and the mud, and possibly a journey of several miles to the nearest place of entertainment. The real countryman is quite at home with Nature in all her moods, but anyone who has been accustomed to the amenities of city life may find the country dreary and depressing during winter.

It is for this reason, and because some experience of commercial poultry-keeping is essential before launching out on one's own account, that the prospective poultry-farmer should have at least twelve months' training on a farm before he invests his capital in the industry. If after twelve months' experience he has lost none of his enthusiasm, and is in fact keener than ever to start a farm of his own, then he should make a success of his work.

Many domestic poultry-keepers frequently secure very high returns from their small flocks. They find that from, say, a dozen birds they have been able to make a profit of perhaps as many pounds. Unfortunately, they assume that if they could get a little place in the country and keep 1,000 layers they would have an income of £1,000 per annum. That is not sound reasoning. There is a wide difference between a dozen birds in a back garden and 1,000 on a farm. Garden poultry-keeping is a hobby, albeit a profitable one; farm poultry-keeping is a commercial undertaking that must bear costs that the small poultry-keeper has probably overlooked. Such charges as labour, depreciation, rent, rates and taxes, and the

thousand-and-one petty items of expenditure, all of which must be paid out of the income from the birds, make garden and farm poultry-keeping entirely different propositions.

Further, while a keen domestic poultry-keeper may obtain an average pullet-year production of 220 eggs per bird, or possibly more, the average for a well-managed commercial farm is somewhere in the region of 200, although of course on individual farms it is considerably higher.

Average egg production is usually expressed in terms of the hen-housed average, that is to say the total number of eggs produced in the year divided by the number of pullets housed at the beginning of the year.

Coles and Shrimpton (1951),[1] discussing varying methods of calculating annual egg production, showed one method that resulted in an average of 129·6 eggs per bird, whereas in fact on the basis of all adult birds in England and Wales in that year they estimated the average to be 145.

Coles (1959) [2] estimated the national average egg production for 1958–59 at 183 eggs per bird.

While some flocks on general farms exceed 200 eggs per bird, they are at present the exception.

If the above figures are compared with the production obtained from the leading pens at the laying trials, it will be seen that there is an abundant scope for improvement.

Business ability is an essential qualification for the poultry-farmer. The fact that he enjoys a country life and understands the needs of livestock is not sufficient to ensure the success of the farm. Many first-class poultry-men are weak on the business side, and have failed on this account. Men of this type should not take a farm of their own; they should be content to occupy a responsible position on a poultry-farm.

The poultry-farmer must study his markets, and he must be able to buy well and sell well. Good buying is not a matter of obtaining quotations and accepting the cheapest. Any schoolboy could do that. Quality and price must be considered, as well as the trend of the market—that is to say, whether prices are likely to rise or fall.

As far as foods are concerned, they must be valued, not on

[1] *Agriculture*, vol. 58, p. 78.
[2] Personal communication.

merchants' prices, but on their effectiveness in maintaining the health and production of the stock. The real value of the food depends on the cost of producing eggs and poultry: that is the crucial test. It follows, therefore, that the cheapest food is not necessarily the most economic; indeed, this is rarely so, for foods of good quality are not obtainable at bargain prices. Feeding-stuffs of inferior quality are always dear in the long run.

Similarly with houses and appliances: it is not the initial cost of equipment that is of primary consideration, but ability of the equipment to do its job and to do it well. Cheap equipment is usually a very bad investment.

There is no better example of this than the cheap brooder that is purchased with more optimism than common sense. An inefficient brooder is a constant source of anxiety and loss. It causes heavy mortality or, what is worse, produces a batch of weakly chicks, which, despite all efforts of the poultry-man, never attain to healthy maturity. Owing to faulty brooding, the chicks have low vitality, they are susceptible to disease, losses occur during the growing stage, and the survivors fail to give a good account of themselves in the laying-house.

Salesmanship is an important factor in poultry-farming. The best markets must be found, and the buyer must be supplied with the material he requires; but the best market is not necessarily the one that offers the highest prices every week. The average price over a period should be considered, together with continuity of demand.

The casual buyer—the man who may call at the farm, offer high prices for a time and then disappears, leaving the producer to find another market when supplies are probably abundant—should be avoided.

When selling hatching-eggs, chicks and stock birds, quality must come first. There are, unfortunately, a great many sources of stock of poor quality—birds that are mass produced or purchased by dealers to sell at prices with which no honest breeder could possibly compete. The poultry-man should not cater for this market, which by the distribution of inferior stock threatens the stability of the entire industry. He should make every endeavour to supply sound, healthy birds with which his customers will be satisfied. In this way a reputation for straight dealing will be built up, and repeat orders will

follow. A satisfied customer is the breeder's best advertisement.

Should complaints arise, they should receive prompt attention, and if found to be justified the supplier should go more than half-way to meet his customer.

A weak link in the business organization of many poultrymen is correspondence. They allow letters to accumulate "until to-morrow", which in practice usually means a long delay in dealing with them. This creates a very bad impression with customers, and may even cause them serious losses if stock is required on a definite date, as it usually is.

The man who hopes to build up a successful business should reply promptly to all letters, or, if this is not possible, he should at least acknowledge their receipt by return of post. The neglect of correspondence is most harmful to business interests. The customer is entitled to know at once whether the breeder is able to satisfy his requirements.

Capital Requirements. Many of the most successful poultry-farmers had very little capital with which to make a start. Indeed, some of them had none. They began with a few birds while following their normal employment, and gradually extended their poultry until they could afford to give up their jobs and rely on their birds for a living.

That is undoubtedly the safest way to start, but it will be realized that those who followed it were either exceptional men or had exceptional opportunities.

Most people must give up their employment at the outset, and for them the question of capital is one of primary importance. What capital is required to start a farm?

This question, in common with many others on poultry-farming, can be answered only in general terms. Before the late war about £1,000 plus sufficient capital to live on for twelve months was considered the minimum. This estimate is based on the assumption that a farm is rented and that approximately 1,000 layers would be carried at the end of the second year. In other words, the capital required was about £1 per bird for stock and equipment. At to-day's values it would be necessary to invest about three times this sum, assuming that new equipment were purchased for all purposes.

It is possible, however, to effect considerable economy where

there are farm buildings which can be adapted for poultry Barns, lofts and other structures may be readily and inexpensively modified for brooding purposes or for keeping poultry on the battery or deep-litter system, and cattle-yards may be used for hen-yards The latter may be transformed at comparatively small cost

It is also possible to effect economy in brooding equipment by the judicious use of brooders employing the hay-box principle, which in recent years have become very popular as a carry-on stage for chicks from about three weeks old Brooders of this type are readily made for indoor or outdoor use

Buying or Renting Given sufficient capital, there is no doubt that it is far wiser to buy a farm than to rent one When a farm is purchased the poultry farmer has complete freedom with regard to lay out and cropping He can carry out improvements with the knowledge that he is enhancing the value of his own property Although these advantages are very great, they should not outweigh other considerations

Prospective poultry farmers are usually men of modest means, and should very carefully consider whether purchasing a farm will leave them adequate capital for their business Many who started by buying a farm found themselves with insufficient "working capital", consequently they were soon in difficulties, and had to give up the unequal struggle when probably the money with which they bought their farms would have been sufficient for their requirements Many have failed when a little additional capital would have enabled them to overcome those initial difficulties with which most business men have to contend

Having regard to these facts, if capital does not permit buying a farm, renting on lease is advised The lease should be for a minimum of three years, with option of renewal Unfortunately it is becoming increasingly difficult to rent suitable holdings The prospective poultry-farmer, therefore, should have property in view before giving up his job, or he may make serious inroads into his capital before finding a place on which to settle down

When a farm is taken on lease the tenant should as far as possible avoid erecting very large houses, which are difficult to remove and if sold may realize low prices The tenant

farmer should have sectional houses and units that can be dismantled and transported in the event of his quitting. He should adapt existing buildings.

Should he not require them, small portable houses usually fetch much higher prices than the larger buildings. They may even realize more than makers' list prices if a number of buyers bid for them, whereas large houses do not usually attract keen competition at farm sales.

Selection of Site. *Acreage.* The system of poultry-farming it is intended to adopt largely determines the size of the farm. Taking two extreme examples—the laying battery and free range—it is possible to keep from 2,000 birds in single cages to about 6,000 in three-bird cages per acre on the battery system and even to provide room for rearing replacements on wire or slatted-floor verandas, whereas on free range with the land cropped in rotation fifty birds per acre will be sufficient. These are, of course, extreme examples; they indicate the versatility of poultry in matters of housing.

The problem should not, however, be approached entirely from this angle. It is essential to consider whether breeding, egg production or table-poultry production is to be the principal object, and on which system it shall be carried out.

Further, if the poultry-man intends to become a specialist egg or table-poultry producer, he should decide whether or not he is to breed his own stock. He will be wise to leave breeding to others. It is a full-time job, which demands great skill and experience. It should be left to men who can give the whole of their attention to it. This is the age of specialization in the poultry world as it is in the business world.

Years ago the average poultry-farmer was Jack-of-all-trades. He was a breeder, a chick producer, an egg producer and a table-poultry producer. By reason of having so many irons in the fire, he rarely obtained maximum efficiency. He usually failed, or at best was only a partial success, as a breeder, and inefficiency at this point was naturally soon reflected in his returns from egg- and table-poultry production.

To-day the poultry-man should be a specialist in one branch of the industry, but that does not mean that he should not be engaged in other branches to some extent. He should,

however, regard one branch as his principal business, and devote most of his attention to it

Elsewhere in this volume the number of birds that may be kept per acre under different systems is stated This information should not be interpreted too literally It is wise to have more than the minimum of land that is actually necessary for the head of stock it is proposed to keep, not only for the purpose of giving it a rest from feathered stock, but having in view possible developments or change of plans

Even on the battery system the full time poultry man should not consider an acre of land sufficient for 2,000 or more layers It is true that the birds can be housed on this area, but there is no scope for other activities, such as rearing stock for sale, or even perhaps breeding on non pedigree lines, which the poultry man may wish to take up when battery egg production is well established Moreover, when space is so restricted there is no possibility of developing side lines such as market gardening or nursery work

It is therefore suggested that, even where it is proposed to work on intensive lines, 8 or 10 acres should be obtained, land not immediately required can be let for the time being

For those who intend to adopt semi intensive or extensive methods or a combination of the two, 15 to 20 acres should be secured for each 1,000 adult birds it is proposed to keep, and where the occupier desires to crop the land, and possibly to keep a few cattle, 50 acres per 1 000 adults would be a reasonable basis to work on

For commercial egg and table poultry production fully intensive methods are now most commonly employed, layers *are kept in batteries on deep litter, in straw yards or in flocks* housed on slatted or wire floors, table birds mainly on littered floors, although a considerable proportion of small chickens of the poussin class are reared in batteries

The broiler system of table poultry production, in which the birds are reared in large groups in confinement from day old to marketing is now firmly established Broiler growing has become a great industry

Intensive housing of breeding and growing stock, long opposed by many, is becoming increasingly common Many leading breeders now keep their breeding flocks in intensive

houses, where artificial light is used during the winter By such methods egg production is more effectively controlled and high fertility and hatchability maintained throughout the season

Intensive housing of growing stock is also becoming increasingly common After the brooding stage the birds may be kept on littered, wire or slatted floors or in straw or pebble yards until four to five months old, when they are moved to their permanent quarters for egg production

On some holdings the birds spend their life on wire or slatted floors—they are never in contact with the ground

In short, intensive systems are being adopted by all sections of the industry, although, of course, it will never consist entirely of intensive plants Extensive methods have their role to play

The very marked change in the pattern of the industry during the past decade—from range to intensive methods—will influence the prospective poultryman in his choice of farm He may decide to operate on a small acreage, but even if he favours a fully intensive system, land surplus to immediate requirements is very desirable

A description of the ideal site for a poultry farm cannot be very helpful to the prospective poultry man, because it is extremely unlikely that he will find it unless he is prepared to pay an exorbitant price

Land agents offer numerous farms which they describe as " desirable ", but when these are inspected they are usually found to have one or more objectionable features It is difficult to find the right type of farm at a reasonable price, but this need not deter, since the majority of successful farms cannot be regarded as ideal poultry holdings in every sense of the term Most of them have disadvantages that their owners tolerate because they realize that their ideal cannot be attained

Usually it requires considerable time to find a suitable place on which to settle down The prospective purchaser or tenant should not be in a hurry to take possession of the first property offered within his means He should inspect as many farms as possible within the area of his choice and give due thought to this very important problem before making a decision

While minor disadvantages, which most farms possess will

have to be accepted, there are certain features that should be avoided For example, land subject to flooding should not be considered for a moment—it is quite useless for poultry-farming

A never-failing supply of pure water is of vital importance, and definite assurances should be obtained on this point Discreet inquiry among local inhabitants will probably throw some light on the matter should it be in doubt In no circumstances should a farm be taken for poultry unless an abundance of water is available, even during the driest seasons Birds drink large quantities—the daily consumption is between 4 and 5 gallons for 100 adult birds—and in addition, water is required for many other purposes, such as washing appliances, preparation of food and so forth Should the supply fail the poultry man is put to great inconvenience and expense and serious losses may result from reduced production due to shortage of water

A piped water supply, either from the main or fed by gravity from tanks, is now essential Carrying water by hand is among the most tedious jobs on the farm, and at existing rates of wages the work may increase the cost of production to a prohibitive extent

The cost of installing water in the principal buildings and leading it to convenient points in the field may appear high, but through saving of labour alone it will represent a thoroughly sound investment It will also take much of the drudgery from the daily chores, and will thus have a good psychological effect on the poultry-owner and his staff

Type of Soil At one time light, sandy soils were regarded as the most suitable for poultry, and years ago experts usually *emphasized the importance of establishing a farm on light land*

In the winter-time light soils are preferable to heavy loams and clays, but in a hot, dry summer the grass soon gets burnt up Medium loam, provided it is well drained, is the most suitable for poultry It does not "puddle" in the winter, while it is sufficiently retentive of moisture to maintain a good sward in summer, except during very dry spells

Heavy clay land, if well drained and not over stocked, is not detrimental to poultry, although unpleasant conditions underfoot are likely to be created for the attendants in the winter If

possible, extremes should be avoided, a good medium loam being the best for poultry in our climate

The quality of the turf is a matter of less importance, because even if the turf is poor, the birds under proper management will quickly improve it

Aspect and Accessibility Level or gently undulating ground protected from the north is the most suitable for a poultry-farm Land sloping sharply to the north, north west or north east should be avoided, as should exposed situations totally devoid of natural shelter Park like land with good hedges is ideal for the purpose, though very difficult to secure

Aspect is of importance even where it is proposed to work on intensive lines Windswept land especially that open to the north, creates difficulties in housing which though not insuperable, are better avoided

The farm should have easy access to a first class road, so that heavy transport vehicles may be brought up to the buildings throughout the year In some instances country properties are approached by a narrow cart track which becomes impassable for vehicular traffic during the winter, hence food supplies may have to be dumped by the roadside and carried by hand to the granary, which may be a considerable distance away Of course, good roads can be made, but they are costly, and the beginner should avoid burdening himself with expenses of this kind

The Residence It is perhaps unusual to mention the residence when discussing the selection of a poultry farm, but it plays a very important part in the success of a business No one can give of his best if the house is uncomfortable and cannot be made into a home where the poultry man and his family can be happy

In the first flush of enthusiasm to launch out, the beginner may be prepared to tolerate inconvenience in his home, but when the novelty of starting a new business has worn off he will be dissatisfied with the lack of home comforts particularly if he is a married man Dissatisfaction will cause restlessness and neglect of work, the business will not then proceed as it should, difficulties will arise, and eventually the farm may be given up because there is not sufficient incentive to make it a success

In these times life in the country should not mean lack of all the amenities enjoyed in the city. The country house should have a modern system of sanitation, hot and cold water, electric light and a telephone.

Electricity is playing an ever-increasing part on the poultry-farm, and, although it is not essential, it is most certainly desirable.

Good outbuildings are a great asset. Barns, granaries, stables, cart hovels and the like will prove most useful and will save considerable capital expenditure, even though they may be in a rather dilapidated condition. Where there are no outbuildings of any kind the question of storage accommodation at once arises, and it will be necessary to lay out capital that is not directly productive.

As a matter of business principles, expenditure of this kind should be kept down to the lowest possible level. Profits are made from the birds, not from the farm's "dead stock".

Public Footpaths. A point well worthy of mention is that of public footpaths. These are a nuisance on the poultry-farm. One or more paths intersecting the property will add considerably to the occupier's anxieties, increase the cost of running the farm, and very probably add to the cost of equipping it.

Those thin lines indicating public rights of way that are seen on ordnance maps should be regarded with the greatest suspicion. The story that these paths are rarely used, and might in fact be closed, should not be accepted. It is extremely difficult to close public footpaths, and although they may be little used in the winter, crowds of holiday-makers may follow them in the summer, and bring dogs that delight in chasing chickens!

Finally, having found a holding that fulfils his principal requirements, the beginner in poultry should get into touch with his County Poultry Advisory Officer, whose services are free.

He should ask the advisory officer to visit his farm, when problems can be examined on the spot. A preliminary discussion of this kind may be the means of averting those common mistakes of beginners that so often have serious consequences.

The newcomer should get to know his Poultry Advisory Officer. From him he will have sound advice, and through him if necessary he can make use of other advisory services

concerned with nutrition, disease and in fact all poultry and farming problems.

Strange as it may seem, some never make use of the National Agricultural Advisory Service (N.A.A.S.) until they are confronted with major difficulties which in most cases could have been avoided had advice been sought in time.

Chapter Three

Systems of Poultry-keeping

There are seven systems of poultry-keeping —

(1) Free range
(2) The semi-intensive system
(3) Straw yards
(4) The intensive system
(5) The deep-litter system
(6) The folding system
(7) The laying battery

Each of these systems represents an economic method of production under suitable conditions The type, area and location of the farm largely determine the system that should be adopted

It should be emphasized that however strongly a given system may appeal to the poultry-man, he should not adopt it unless his farm is suitable Many have attempted to make the farm suit the system, with the result that serious difficulties have arisen Circumstances determine which system is the most economic for the farm

Moreover, the purpose in view must be considered—that is to say, whether breeding, table poultry, egg production or the production of growing stock is the principal object

A system that may be admirably suitable for the general farm or small holding where poultry-keeping is merely a part of the farmer's activities may be totally unsuitable for the specialist poultry-farmer

In practice two or more systems are commonly used on the same farm For example, chicks are frequently reared intensively until they are six or eight weeks old, when they are placed on free range until mature, the laying stock may be kept on deep litter or in batteries, the breeding stock may be run on the semi-intensive system

Free Range. Free-range poultry-keeping should be adopted only where an adequate area of land is available to ensure a low rate of stocking and/or rotational methods—*i.e.*, where the land is not permanently occupied by poultry, the birds being moved from field to field in accordance with the general cropping programme.

Free range for all classes of poultry stock, growers, layers and breeders is possible only on the larger specialist and mixed farms. The poultry producer who wishes to maintain a flock of, say, 1,000 layers on 6 or 8 acres cannot practise it because it would mean over-stocking for permanent occupation.

Photo: Modern Poultry Keeping

FIG. 1.—FREE RANGE. A SCENE ON A GENERAL FARM SPECIALIZING IN POULTRY

A flock of Light Sussex hens mated to Rhode Island Red cockerels. An example of free-range poultry keeping

If free-range methods were attempted in these circumstances the land would become foul and poultry-keeping unprofitable owing to high mortality from disease. There would be no opportunity of giving the ground a rest from feathered stock, and at certain periods when the farm was carrying its maximum head of stock there would be serious overcrowding.

Poultry-farmers sometimes speak of keeping birds on free range when they are in fact keeping some 300 birds per acre. That is not a reasonable or practical interpretation of the term.

If this system is to be applied with success the average rate of stocking should not exceed 100 birds per acre. This should be regarded as the maximum for adult stock; the optimum is nearer 50 than 100, and these figures should be further reduced where the birds are only part of the farm's livestock. Even this does not take into account the land required for rearing

Heavier stocking is, of course, permissible for a time In practice this is quite customary where poultry-keeping takes its place in the farm's rotation, but in estimating the number of birds that may be kept on a given holding one should always be conservative Understocking has never caused trouble

There is, however, much more than the number of birds per acre to be considered Over-concentration in the field is not a practical proposition, even though the area per bird is adequate

To keep very large flocks in houses spaced a yard or so apart represents thoroughly bad management At feeding-time the birds congregate in a mass, so that the more nervous individuals are bullied and do not get their fair share of food In these circumstances it is impossible for the feeder to keep the stock under proper observation, he cannot detect individuals that are not feeding well or those that are showing symptoms of ill-health Such flocks almost invariably contain a number of poor producers and possibly sick birds that may spread infection throughout the flock

When houses are close together some are overcrowded at night, while others contain only a few birds It is a laborious job moving birds from one house to another, but unless this is done an epidemic of colds or more serious disease is almost inevitable

Thus it will be seen that free range can be generally adopted only on the larger holdings If attempted on small areas it is impossible to keep the stock under control, while the risk of land becoming foul is very great It is a system suitable only for the general farm

As stated in Chapter One some 70 per cent of the laying flocks in the country are now housed intensively, primarily to ensure high egg production during the autumn and winter months and as a means of saving labour

It is not implied that high production cannot be obtained from extensively kept stock in winter, but it is far more speculative, among early hatched pullets out of season moulting is usually prevalent, whereas kept intensively and given artificial light not more than about 10 per cent should moult in normal circumstances And they usually moult rapidly

Generally speaking, free range methods are economic for small

flocks managed by family labour. Large flocks maintained for commercial egg production must give high egg yields in the autumn and winter months to offset higher overhead costs, and this demands intensive methods if the desired results are to be consistently obtained season after season.

The Semi-Intensive System. The semi-intensive system means keeping birds in fixed solid-floor houses and giving them access to grass runs. It is still widely practised, but its success depends on keeping the ground in good condition.

After the 1914–18 war, when the poultry industry was enjoy-

Photo: Modern Poultry Keeping

FIG. 2.—THE SEMI-INTENSIVE SYSTEM. THE SEMI-INTENSIVE SYSTEM WITH ALTERNATE RUNS

A scene on a breeder's farm in the West of England

ing a boom, many people took small farms and adopted this system; indeed, at that time they had no alternative, because the intensive system had not been evolved.

In those days the large flock was favoured, and it was by no means uncommon to find long-range semi-intensive houses containing 500 to 1,000 birds. There appeared to be some rivalry between poultry-men to own the largest house in the district, if not in the country.

These houses were more spectacular than economic. Apart from the impossibility of keeping so large a flock under close observation, it proved extremely difficult to maintain the land in good condition. This applied especially where the semi-

intensive system of rearing was adopted. Under these conditions the land quickly became contaminated with such diseases as gape-worm and coccidiosis, and appalling losses occurred among young chicks.

It would be untrue to say that the system cannot be successfully practised. On the contrary, it is the basis of the system employed on many farms to-day, but not as it was applied in the early 1920s.

To-day the large flock-house has almost disappeared for semi-intensive work. It has been replaced by smaller houses for flocks of from 50 to 100 birds, and every care is taken to prevent ground contamination. Two or more runs are

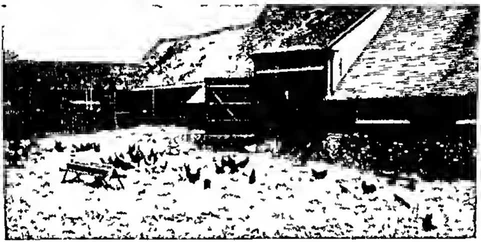

Photo: Modern Poultry Keeping

FIG. 3—A TYPICAL EXAMPLE OF THE STRAW-YARD SYSTEM

attached to each house, and are occupied in turn, each run being given an adequate rest from feathered stock and periodically dressed with lime On many farms the runs are cultivated or are grazed by sheep or cattle.

The greatest danger arises from the ground immediately around the house, which soon becomes "that foul patch" familiar to all experienced poultry-men. To obviate this, at least to some extent, it is advisable to lay a concrete or gravel surround, sloping away from the house, with a gutter along the outer edge to drain off the water. Alternatively, a slatted or wire-floor balcony raised about 12 in. from the ground, and extending, about, 6 or 8 ft. from the house, could be erected.

For semi-intensive housing the runs should have an area equivalent to not less than 8 sq. yd. per bird, or a minimum of 16 sq. yd. for two runs. This permits a maximum rate of stocking of 300 birds per acre.

Straw-yards. The straw-yard or hen-yard system has been adopted on many general farms throughout the country during the expansion of the industry which began after the Second World War.

The capital cost of converting existing cattle-yards is usually

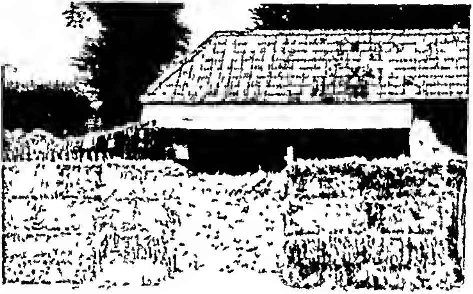

Photo: Modern Poultry Keeping

FIG. 4.—OPEN-FRONTED FARM BUILDINGS ARE READILY ADAPTED FOR THE STRAW-YARD SYSTEM

very modest, in some cases as low as 2s. or 3s. per bird, while yards involving new buildings may cost, when fully equipped, in the region of 15s. to 20s. per bird.

Moreover, the system results in great economy in labour. Straw-yards, being in, or close to the farm buildings, a man can undertake all the daily routine work of feeding and egg collecting in a matter of a few minutes. It is impossible to state precisely the actual labour required in the management of a flock of 300–500 birds on this system, but provided water is laid on and other means are taken to avoid unnecessary work, one hour daily should suffice.

The buildings of the yard are used as the house section of the unit. They are fitted with nests, usually of the communal type, feed-troughs and drinkers. Perches or slatted roosts are placed over manure-pits from which the manure is removed once a year—usually in the late summer, when the buildings are thoroughly cleaned prior to re-stocking with pullets.

The term "droppings pit" is a misnomer, for the pit consists of a section of the building surrounded by brick or concrete walling about 2 ft. high which carries the perches or slatted

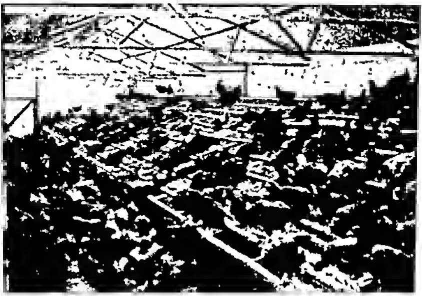

Photo: Modern Poultry Keeping

FIG. 5.—THE STRAW-YARD ROOST

A popular method of arranging the perches in the house section of a straw-yard.

frames. Perches 2 in. × 2 in. or 3 in. × 2 in. (2 in. side top) are fixed 15 in. apart to framing which rests on the wall. The frames should be of convenient size for easy removal when the pits are cleaned. Under the framing 3-in. mesh wire-netting should be fitted to prevent the birds scratching among the droppings. This diminishes the risk of worm infestation. Eggs laid at night can be collected through wire of this mesh. Droppings accumulate on the netting if a smaller mesh is used to catch the eggs, which are often broken on the wire, and this may induce egg eating.

Some poultrymen do not favour droppings pits, but prefer

droppings boards because they give less encouragement to rats and insect pests.

The house section should provide a minimum of 2 sq. ft. of floor area per bird (including the droppings pit, 1 sq. ft. per bird) and must be adequately ventilated. It is essential to provide the birds with fresh air without draught. This does not usually present a difficult problem, but the matter must be given attention if epidemics of colds and more serious diseases are to be avoided.

In sheltered situations the open-fronted type of house is suitable for use with a straw-yard. The front of the house should be fitted with glass or hessian-covered frames to keep out driving rain.

In some yards the house is entirely open-fronted with an adjustable hood of hessian cloth under the front eaves, the lower part of the front being boarded or bricked up about 18 in. from the floor.

In the open-fronted type of house there should be no other ventilation except an adjustable ridge cap or other controlled roof ventilation for use during the spring and summer months.

In winter, ventilation should depend on the open front only. This will provide an abundance of fresh air for the birds without creating draught.

On exposed sites the straw-yard house should be boarded up in front to about 3 ft. from the ground with suitable hessian screens or windows above the boarded part to admit air and light. Adequate ventilation must be provided.

Doors and windows should be thrown open as much as possible, and during the summer should remain open day and night

Roof lighting is excellent in straw-yard houses, and many yard buildings depend on them.

Where buildings or portable houses are not available houses built of straw bales or thatch, hay, asbestos-cement sheets or galvanized iron may be used.

Usually deep litter is practised in straw-yard houses. The litter is renewed annually. The houses should be equipped for artificial lighting. This is essential for maximum winter egg production.

The yard part of the straw-yard should be an area equivalent

to about 4 sq ft per bird for large flocks and up to 6 sq ft per bird for small flocks It must be well drained and sheltered

If surrounding buildings do not provide adequate protection, the yard should be enclosed by three courses of straw bales with 2 or 3 ft of wire netting over them, or a wall built of wire-netting attached to both sides of the supporting posts, the space between the two rows of netting being stuffed with hay or straw If the lower part of the yard wall is not built with straw bales it should be made with galvanized corrugated sheets firmly supported to withstand the considerable pressure of the litter

The birds should not be confined to the house section of a straw yard They should have access to the yard at all times irrespective of weather conditions

The system requires a considerable quantity of straw, and is therefore most suitable for arable farms

Sykes (1952) estimates that about 8 cwt of loose straw weekly throughout the winter is sufficient in each yard of 500 birds In the summer he finds that a load of fresh straw once a fort night, or even once a month, is adequate He suggests that ten tons a year for a 500 bird yard is required But some yards are very thinly littered during the summer months

Good conditions should be maintained underfoot The amount of straw required will, of course, depend largely on the weather A larger quantity will be required in a wet season than in a dry one

Any kind of straw may be used but wheat and oat are the most satisfactory

Fresh green food or roots are not essential if the diet is properly balanced, but if supplies are available moderate amounts will provide interest for the birds, and thus are of value in preventing cannibalism

Rats may be troublesome in hen yards since for obvious reasons it is rarely possible to make the buildings vermin proof However, the use of well designed feeding troughs, which should be suspended from the roof of the building, and the constant turning of the litter, will do much to deter them Never theless, rats will make their appearance and the best method of dealing with them is by routine trapping poisoning and gassing If the work is done properly they will not cause serious trouble

The straw-yard system presents a cheap method of housing and a means of reducing labour costs. It provides the advantages of the intensive system, but gives the birds the benefit of an out-door life.

Wherever possible the yard should be stocked with birds of the same age; then it can be treated as a unit for the purpose of accounts, and at the end of the season all the birds can be sold together. It is not wise to keep birds of different age groups in one flock.

The principle of the straw-yard is now commonly applied to houses of all types. Field and semi-intensive houses are often seen with yards attached in which the birds are either confined permanently or only during inclement weather. The additional protection thus afforded is an aid to winter egg production and assists in maintaining high fertility among breeding flocks.

Gravel-yards. In districts where straw is expensive yards may be constructed with gravel. Rounded pebbles of about 1½–2 in. diameter are the most suitable. The material must be laid on a firm, well-drained foundation.

Small or cracked pebbles should not be used.

Pebbles should be spread to a depth of about 6 in., preferably on a hardcore base. Steps must be taken to prevent litter being scratched out of the house pop-holes and so forming an insanitary mat at these points.

Four sq. ft. yard area per bird is adequate.

Rain will usually keep the yards clean, the droppings being washed through the gravel; in dry weather the use of a hose-pipe may be desirable. Yards paved with pebbles have been used with success on some farms for many years.

Yards having a capacity of up to 500 birds are efficient under skilled management. Beginners should work with smaller flocks. They should regard 250 birds as the upper limit for one flock.

Gravel-yards, in common with straw-yards, are suitable for growing pullets. Many flocks are so kept prior to housing in batteries or on deep-litter.

Concrete-Yards. Concrete-yards are an alternative to straw- or gravel-yards, especially where straw or gravel is expensive.

Moreover, it is often difficult to maintain good conditions

underfoot in straw-yards during wet weather, and in some instances gravel-yards become messy.

Concrete solves these practical difficulties.

Concrete-yards should have a gentle slope so that they can be hosed from time to time. About 3 sq. ft. yard area per bird will be ample for both laying and breeding stock.

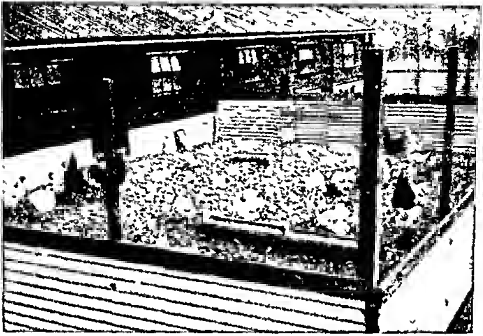

Photo Poultry Farmer and Packer

FIG. 5A.—BREEDING STOCK ON A GRAVEL-YARD

The Intensive System. The intensive system means keeping birds totally confined to the house. In order to grasp the fundamental principles of the system, it is necessary to make brief reference to the work of the pioneer investigators, for had it not been for their untiring efforts the poultry industry could not have developed on its present lines; it is, in fact, extremely doubtful whether it would have become a great national industry.

For many years attempts were made to rear chicks in total confinement. They failed because the chicks developed so-called "leg weakness", which we now know is due to rickets. Similarly, attempts to keep adult birds in total confinement also failed. They laid thin-shelled, then shell-less eggs, and finally, like chicks, developed "leg weakness". When they were given

an earth or grass run both chicks and adults quickly recovered, provided the trouble was not too far advanced. It was therefore concluded that birds must have contact with the ground.

In experimental work on rickets in puppies Mellanby (1918) used certain rations, and as a result of his observations suggested that fats contained an antirachitic vitamin.

In 1921 Pappenheimer, McCollum, Simmons, Parsons and others carried out experiments on rats, and agreed with Mellanby's conclusions—namely, that rickets could be produced by depriving the animals of fat-soluble vitamins.

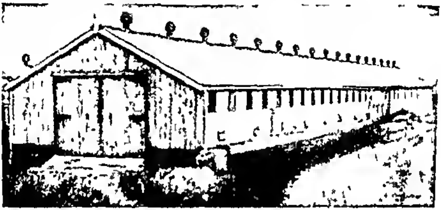

Photo Poultry Farmer and Lake

FIG. 6.—THE INTENSIVE SYSTEM

A modern deep litter intensive house It is divided into two sections by a central food store The house is double boarded throughout and has controlled ventilation

Before Mellanby's work rickets was attributed to close confinement and lack of exercise. He showed, however, that closely confined puppies did not develop rickets if given an adequate ration. He also showed that rickets developed if they were given *their freedom but an inadequate diet.*

That the problem was not entirely nutritional was shown by Huldschinsky and others, who in 1919 found that rickets could be cured by exposure to the ultra-violet rays of a mercury-vapour lamp, while in 1921 Hess and Unger obtained equally successful results by exposure to sunlight.

Chick and her co-workers produced conclusive evidence that rickets could be cured by exposure to sunlight and ultra-violet rays.

Thanks to the work of the pioneers in vitamin research, the

intensive system of poultry-keeping became feasible. The poultry industry, as we understand it, could not have been built up had it not been for their discoveries.

Vitamin D3, of which cod and *certain* other fish-liver oils are rich sources, is necessary for the assimilation of mineral matter essential for bone and shell formation.

Exposure to ultra-violet rays (present in direct sunlight—*i.e.*, sunlight that has not passed through ordinary glass) enables vitamin D3 to be synthesized in the body.

Expressed very simply, this means that rickets can be prevented by exposing the birds to sunlight or by the inclusion of an adequate source of vitamin D3 in the diet, provided always that it is not deficient in mineral matter.

The success of the intensive system depends fundamentally on exposing the birds to direct light, or, if this cannot be accomplished, by adding cod-liver oil or synthetic vitamin D3 to the ration. Artificial irradiation with ultra-violet rays has proved successful, although it does not appeal to the practical man who has cheaper and more convenient means of providing his birds with their vitamin-D requirements.

Today the majority of chicks are reared in confinement at least for the first three or four weeks and a large proportion of laying stock is kept on one of the intensive systems.

Whereas formerly it was considered essential to keep the birds in houses which could be flooded with sunlight, exposure to direct light now receives little consideration, since for intensively kept stock diets which provide adequate amounts of vitamin D3 in natural or synthetic form are readily compounded.

Thus the open-fronted intensive house is now rarely seen, modern practice being to build houses not subject to great extremes in temperature.

Disadvantages of the Intensive System. While the intensive system has many advantages, its disadvantages are: (1) the relatively high cost of housing, (2) the tendency of birds kept in close confinement to acquire vices such as egg-eating, feather-plucking and cannibalism, (3) higher risk of disease inseparable from greater density of population.

The first may be largely offset by the saving in the cost of land, labour and marketing. By adopting this system the producer may keep a large number of birds on a small plot of

land in close proximity to good markets, whereas extensive methods usually mean going farther afield.

High capital cost, however, is justified by the higher average egg production secured by intensive housing, and particularly by high production during the autumn and winter months, when egg prices are at their maximum level.

The second difficulty must be regarded as one of the hazards of intensivism. It cannot be denied that birds are more subject to feather-plucking and other vices when they are kept in total confinement, and one must be prepared to adopt suitable counter-measures immediately these occur.

So far as the risk of disease is concerned, it can be minimized by sound management, which includes, of course, the feeding of balanced diets and the avoidance of crowding. Intensive houses must be well ventilated but free from draught. Inefficient ventilation predisposes the birds to diseases of many kinds, especially respiratory troubles.

The Deep-litter System. Contrary to the belief of many, the deep-litter or built-up litter system of poultry-keeping has been practised in this country for many years. It was employed over thirty years ago, and it has been applied with success in houses and buildings of many types. Over a long period the writer adopted the system in semi-intensive and later intensive houses having concrete and earth floors and wooden floors raised on brick piers well up from the ground.

In those days the litter most commonly used was peat-moss, straw being added from time to time. The litter was forked over at intervals, but was not changed during the production year—i.e., from late August or early September to August of the following year. Throughout this time the condition of the litter remained satisfactory. If it became too damp it was forked over more frequently and ventilation was increased by opening windows.

In recent years the system has been widely adopted in North America, and American methods have received much publicity in this country. In fact this system differs only from the orthodox intensive system in that a considerable depth of litter is used and it remains in the house for a year, in some cases two years, or even longer.

But the term "deep litter" usually implies large or comparatively large flocks kept in total confinement in converted buildings and larger poultry-houses adapted to the system. Many firms now supply houses of diverse types specially designed for the purpose. Not all these houses are equally efficient by any means.

Any well-constructed, well-ventilated building capable of maintaining a moderate temperature during the winter months

Photo Poultry Farmer and Packer

FIG. 7.—SECTION OF A MODERN DEEP-LITTER HOUSE

Birds shown are a breeding flock for the production of broiler chicks

may be used for deep-litter work. Whether or not it is necessary to insulate such a building continues to be a matter for controversy. There is no doubt that the litter may remain in good condition and high levels of winter egg production may be obtained without insulation; but all experimental work has shown that the more constant the environment if within the ideal range (about 55° F.), the better the average winter egg production over the years, and the greater the feed-conversion efficiency.

The fact that the litter keeps dry is no criterion that conditions cannot be improved; it may keep dry in open-fronted houses even during cold weather, but in these circumstances a

greater proportion of the food consumed will be needed to maintain body heat compared with the amount required by birds in warm houses.

Constant Environment. The influence of constant environment on egg production and other traits has been studied by Greenwood at the Poultry Research Centre, Edinburgh.

The experiment began with March (1952) hatched pullets from a single hatch which were subsequently divided into two groups. One group was housed under normal intensive conditions, with night lighting in winter; the other group of sister pullets was kept in a climatic chamber in which the temperature was maintained at 65° F., humidity at 60 per cent and in which strip lighting (no daylight) was used to provide a twelve-hour day throughout the period of the experiment.

Three laying seasons were completed in 1955. Results are shown in Table 10.

TABLE 10

Effect of Constant Environment on Egg Production, Hatchability and Feed Consumption. Poultry Research Centre, Edinburgh.[1]

Per bird	Constant environment. 19 hens: 1 cock.				Controls 18 hens: 1 cock.			
	1st year.	2nd year	3rd year.	Total	1st year.	2nd year.	3rd year.	Total
Egg production (hen-housed)	234	147	94	475	193	170	148	511
Top 12 birds	253	180	135	568	216	187	165	568
Chicks hatched per bird	188	87	27	302	159	143	89	391
Total food consumed (lb.) per bird	79	76	62	217	77	71	69	218
Total food consumed (oz./day)	3½	3½	2½		3½	3½	3	

At the end of the first year there was a difference of about forty eggs per bird in favour of pullets kept under constant environment, but in subsequent years the control group gave substantially higher production. The same story can be told with regard to hatchability. The extremely low food consumption

[1] Greenwood. Personal communication.

(with a high-energy mash, plus a daily allowance of $1\frac{1}{2}$ oz grain per bird) is a feature of this experiment

In the first year the annual moult of the birds under constant environment was delayed considerably and was sporadic In this group there was a tendency for some of the birds in the second and third year to stop laying and not to start again

After seven years all the birds in the constant environment had died, but of the controls, 70 per cent were still alive at this age

This work suggests that constant environment at the above levels results in early senility

Adequate ventilation of deep-litter houses is essential not only for the health of the birds, but to reduce condensation, and thus to assist in keeping the litter in good condition

In North America great stress is laid on the importance of insulation, whereas the ventilation of some houses would be regarded as inadequate judged by British standards It should be recognized, however, that climatic conditions in America are entirely different from those prevailing in this country

Any of the materials commonly used for litter are equally suitable for the deep-litter system Peat moss, sawdust, shavings and cut straw are frequently employed either alone or mixed. Some prefer a mixture of sawdust and straw or shavings, while others use peat-moss and add straw or other litter to it in the building-up process Cost is the deciding factor in choice of litter. Oak sawdust should be avoided, as it may cause discoloured yolks, and resin in hardwood sawdust may taint the eggs

There are two methods of starting deep litter Some begin by putting down litter to a depth of 2 or 3 in , leaving it undisturbed until it is heavily charged with droppings and begins to get damp At this stage further litter is added at intervals of perhaps ten days, according to the condition of the litter in the house, until it is built up to a depth of about 8–10 in The new litter should be well mixed with the old by stirring with a fork

The majority of poultrymen, however, commence by putting down litter of the required depth at the outset, although this method entails more labour in stirring until the litter is established A great depth of litter is undesirable It need not

exceed 8 in., and in some cases 4–5 in. or even less is adequate. This is a matter for discretion.

As soon as the litter shows signs of getting damp and compacting it should be thoroughly forked over. Stirring is essential to ensure uniform distribution of organisms on which the success of the system depends.

Provided a start is made before the cold weather sets in, it should be possible to establish the litter in well insulated and ventilated houses or even in open fronted houses without the use of hydrated lime. Mixing lime with litter that is unduly damp will have a drying effect, because it assists in keeping the litter open and thereby increasing evaporation, but it reduces the population of bacteria, moulds and yeasts, and for this reason it should not be used except as an emergency measure.

If the litter cannot be kept dry—i.e., friable—by stirring, then hydrated lime may be mixed with it at the rate of 8–10 lb. or even up to 15 lb. per 100 sq. ft. of floor area, depending on the degree of dampness. Further applications should be made should dampness recur.

The lime should be forked into the litter, care being taken to avoid unnecessary dust, as it has an irritating effect on the respiratory organs. For this reason where the birds are confined to the house it is advisable to apply lime to about half the area at one time, so that they are not in the part where lime is being spread.

Superphosphate, ground limestone, gypsum and other minerals have been used successfully, but hydrated lime is preferred by the majority of poultrymen. Quicklime *must never* be used for this purpose, owing to the risk of fire and poisoning the birds. Superphosphate is most effective in reducing the loss of nitrogen from the manure (see p. 471).

If the system is properly applied, deep litter is not dirty litter. After a short time the litter becomes heavily charged with bacteria and other micro-organisms which break down the manure and litter particles into a friable mass. The decomposed manure becomes part of the litter. In the process the animal protein factor is produced (see p. 415). Established deep litter is an excellent source of this factor.

The phenomenon is precisely the same as the decomposition of manure and other material in the soil or in a compost heap.

The organisms not only break down the manure, but use the moisture in the droppings, while the heat generated in the litter results in further evaporation of moisture. Thus it keeps dry. But it should not become dusty. A friable condition is ideal.

Deep litter should be stirred frequently and thoroughly in the early stages, but when "working" properly it will be sufficient to fork it once every few weeks. During spring and summer stirring should be unnecessary, but should the litter become unduly dry and dusty it should be watered occasionally. Watering will stimulate the activity of the litter organisms.

It is impossible to give definite advice with regard to litter management. The frequency of stirring, the amount of lime to be used, if any, and other matters in deep-litter management must depend on circumstances.

It is wise to make a start with built-up litter by August. If left later, it is difficult, especially on wooden floors, to avoid stickiness and the litter compacting.

As the process of built-up litter depends upon the interaction of bacteria, yeasts, etc., some commence with a layer of 2 to 3 in. of old litter (or a little stable manure) which is heavily charged with organisms and acts as a "starter". This is recommended when the house is littered late in the season.

Birds are frequently housed in large flocks on deep litter. In North America thousands of birds may be run together in houses of several storeys, and the number of birds under the management of one man may exceed 10,000. In this country smaller flocks are preferred. Flocks exceeding 500 birds are exceptional. For the most efficient management, and as a precaution against disease, units of 300–400 should be considered the maximum. Usually better returns will be obtained from even smaller flocks of about 250 birds.

Droppings boards are not usually provided in deep-litter houses. Instead, perches, wire or slatted frames are placed over droppings pits, the latter being along one side of the house or in the centre with littered floors on each side.

Some use portable perches arranged in units of convenient size, additional perching space being provided by the perches attached to the food troughs.

With portable perches droppings pits are unnecessary, but

the perch units must be moved at intervals to ensure uniform distribution of the manure.

Droppings pits are preferred by the majority of poultrymen. They save labour and assist in keeping the litter in good condition, since they reduce the amount of manure falling on to it. Nevertheless, if the litter is working properly it will break down day and night droppings. Droppings pits should be constructed on the lines recommended for pits in straw-yards, allowing about 1 sq. ft. of pit area per bird. The perches (at 15-in. centres) may be mounted on framing at one level or sloping upwards, ladder fashion, towards the wall.

Economy of floor space can be effected by the use of slatted frames instead of perches. Frames, of convenient size for easy removal, should be made of 1-in. chamfered slats 1½ in. apart. They should be fitted over droppings pits.

Total area of slatted roost should be equivalent to ¾ sq. ft. per bird. This will provide ample space.

Droppings pits are usually cleaned out once a year. Where the floor is of wood, the area of the pit should be liberally dressed with preservative to prevent rotting. Hydrated lime or superphosphate should be sprinkled over the droppings in the pits at regular intervals. Lime deters rats and assists in conserving nitrogen in the droppings.

The total floor area per bird should be from 3 sq. ft. in large flocks to 4 sq. ft., in small flocks.

About 3 sq. ft. floor area (including droppings pit) per bird is the normal allowance for commercial flocks kept in deep-litter houses of conventional lay-out as described above.

Many of the newer deep-litter houses, however, have one-third or more of the floor area consisting of a droppings pit with horizontal slatted or wire-mesh covering on which some of the food and water troughs are placed.

Since the birds spend so much of their time on the slatted or wire-mesh section, the total floor area per bird can be reduced to about 2 sq. ft., and if multiple-tier perches are arranged over the manure pit floor space may be further reduced to 1½ sq. ft. per bird.

Communal type nests are used. On some plants they are placed in a separate section of the house, which becomes in effect a laying-room.

Feeding of deep-litter stock usually consists of dry mash *ad lib* supplemented with grain or pellets and the usual grit mixture

Fresh green-food is rarely fed to flocks on deep litter It is difficult to maintain a supply of good-quality greenstuff, but when it can be assured a small daily allowance will minimize the risk of vices and deepen the colour of the yolk

Greenstuff should be fed in racks About ½ oz per bird daily is a suitable amount

Cannibalism is always a hazard where flocks are closely confined To guard against this the birds' beaks are often pared, or "hen-spectacles" or pick guards (visors) fitted

Since the deep-litter system became popular many have asked whether it is a suitable system to adopt for chick-rearing and breeding-stock

These are controversial matters, and poultry-men express widely divergent views about them

Rearing on Deep Litter Kennard and Chamberlin (1949) reported the results of trials in which built up litter was kept in almost continuous use for eight consecutive batches of chicks Trials were also made with chicks reared on new built-up litter and on litter renewed every two weeks "Serious losses were experienced from coccidiosis and other diseases when the floor litter was renewed at frequent intervals and losses were reduced from an average of 19 per cent to 7 per cent after the use of built-up litter"

The rates of mortality among successive broods "indicate that it requires two or three broods of chicks or the continuous use of the floor litter (at the rate of one bird to each square foot of floor space) for 9–12 months before the full beneficial effect upon the livability of chickens can be realized"

It is well known that chicks exposed to sub-lethal doses of coccidia can acquire great resistance to the parasites

Kennard and Chamberlin (1951) have pointed out in explanation of the sanitary activities of built-up litter that nearly all bacteria and other organisms have their enemies in built-up litter, the ammonia generated in the litter is a disinfectant particularly for coccidiosis, and chemical and biological activities are similar to those of the compost heap

Despite the acknowledged advantages of deep litter for

chicks, it has its disadvantages and does not receive unanimous approval.

In some cases high concentration of ammonia has affected the chick's eyes, even to the extent of causing blindness; but there must be some error in management if ammonia becomes so concentrated. In other cases chicks have been found heavily infested with round worms, caecal worms and coccidia. Serious epidemics of coccidiosis have occurred under this system, and where litter conditions result in the destruction of coccidia, the chicks are susceptible when exposed to infection. Thus losses may occur after they leave the brooder-house.

Furthermore, when reared on deep litter, chicks may be exposed to fowl-paralysis and leucosis infection carried over from previous batches of chicks.

Experience, mainly in table-poultry (broiler) production, has shown that under favourable conditions it is possible to rear successive batches of chicks on the same litter. Among broiler producers it is common practice to replace the litter under the brooders only, the remainder being heaped up to heat and then re-spread.

When rearing pullets intended for laying and breeding stock it is wise in the light of present knowledge to replace the litter on account of possible carry over of fowl paralysis, leucosis and perhaps other infection.

Although chicks reared on new litter may soon be exposed to greater infestation of coccidia than those on old litter that has been heated, treatment with one of the drugs now in common use usually controls the disease and, as explained in Chapter Twenty, chicks so treated are highly resistant to subsequent attack by the same type of coccidia.

Should the same litter be used repeatedly for chicks, it should be heaped up after each batch. Litter should be heaped in piles about 4 ft. high and left for five or six days to heat. The temperature of moist litter when heaped will soon attain 130–140° F. a few inches below the surface; this is sufficient to ensure the destruction of worms and coccidia.

After heating for about five days the litter should be re-heaped, so far as possible the litter outside the first heap being inside the second. Again it should be left for about five or six days to heat up and should then be spread over the floor.

Heated litter is quite safe for re-use, provided the temperature rises above 130° F. (54·4° C.).[1]

Dry litter will not heat properly. It should be dampened prior to heaping and the heap may be finally watered.

If it is intended to use old litter either wholly or in part for adult birds it should be treated on the above lines. But most farmers and smallholders are able to use old litter on the land, and will therefore prefer to begin each season with new litter.

While heating the litter is proceeding, the house should be thoroughly cleaned and disinfected. The double heating process can be completed in twelve days. After disinfection and litter treatment the house is ready for use. It is unnecessary to leave it unoccupied for a short rest period.

Many broiler producers heap up the litter between batches rather than use new litter for each batch.

Breeding on Deep litter. Kennard (1949), in a paper presented at the Ohio Animal Nutritional Conference, showed the great value of built-up litter in improving hatchability when incomplete diets were fed.

"In no instance were the breeders on fresh litter able to produce eggs of good hatchability from any of the diets used in these experiments. Whereas all the diets (except the basal ration with alfalfa meal only) yielded eggs of 80 per cent or better hatchability from the breeders on built-up litter. Obviously, the failure of the breeders on fresh built-up litter to produce hatchable eggs was due to deficiencies of riboflavin and the animal protein factor."

In North America deep-litter breeding has been practised for many years, for the reason that in many areas of the country climatic conditions do not permit breeding on range. Therefore the success of the system cannot be doubted, but there is considerable doubt as to whether it is the best system under conditions prevailing in Great Britain.

There is prejudice against deep-litter (and straw-yard) breeding among our poultrymen, but those breeders who can produce the most profitable stock will ultimately secure the major share of the chick trade whatever system they adopt. In the end, it is profitability that counts. Breeding from stock

[1] On many farms litter is heaped once only.

intensively housed on deep litter is now carried out on a number of farms in this country. Provided the birds receive a balanced breeders' diet and general management is sound, results are usually satisfactory, particularly early in the season when most breeders report higher egg production and better hatchability. But towards the spring some have experienced a marked decline in hatchability and to a lesser extent in egg production, which suggests that some problems associated with the system for breeding stock are not fully understood.

To counter the spring decline in hatchability some breeders confine the birds to the houses only during the short winter days. As spring approaches they are given range. Others housing their stock on deep litter provide straw-yards in winter.

When housed intensively the combs of cockerels grow to an abnormal size. They are flabby, comparatively thin and frequently lop over to one side.

The enlargement of the comb in these circumstances is not a reflection of male hormone activity; it is associated with temperature, the warmth of the intensive house stimulates comb (and wattle) growth.

Cockerels with overgrown combs are vulnerable to attacks by other males, and the combs may prevent the birds feeding well, especially if the troughs have spinner bars along the top with insufficient clearance.

Single-comb cockerels intended for service in intensive houses should be dubbed.

Deep-litter housing implies labour-saving methods. Water and electricity should be laid on, nests and food troughs arranged to save unnecessary steps.

Well-designed and equipped houses, grouped on a convenient site, should enable a competent poultryman to look after about 4,000 or 5,000 layers, that is to say to attend to daily routine tasks. But, of course, he must be given relief at week-ends and holidays and have assistance with additional work from time to time.

Greenwood,[1] director of the Poultry Research Centre, Edinburgh, has bred from successive generations of Brown Leghorns kept intensively since 1930. The flock is closed, that is to say, no birds from outside sources have been introduced, and is

[1] Personal communication.

divided into eight non-interbreeding lines. For all pullets hatched in the four years 1953–57, the hen-housed average was 170 eggs, and survivors 189; the corresponding figures for the two best lines, specifically selected for egg production, were 195 and 226. Mortality was 17 per cent. In the various groups of interline crosses raised over the same period, average hen-housed production ranged from 187 to 229 eggs.

All-wire or Slatted Floors. More recently the all wire or slatted floor intensive house—the term deep-litter is obviously

Photo Poultry Farmer and Packer

FIG. 7A.—ALL WIRE-FLOOR HOUSING

These birds are housed at approximately 1 sq. ft. per bird. Note the two-tier roll-away nests which back on to the central service passage. (See page 607 for the construction details.) This house is windowless

a misnomer—has been introduced. Some deep-litter houses have been so converted.

The floors are built in sections of convenient size for ease of removal for cleaning out the manure. Floors should be about 2 ft. 6 in. from the floor proper. Their construction is discussed in Chapter Nineteen.

On this system of housing total floor area equivalent to 1 sq. ft. per bird is adequate for laying stock in medium-size or large flocks.

On some farms the system has been adopted successfully for breeding stock, allowing greater floor space of about $2\frac{1}{2}$ sq. ft. per bird.

The all-wire and slatted-floor housing systems seem destined to find a place in poultry production. On some holdings the deep-litter system is not a success; moreover, in many areas litter is in short supply and is costly.

Possibly a combination of slatted or wire floor and a solid floor, the latter forming 20–30 per cent of the total floor area, will prove the most satisfactory, particularly for breeding as distinct from table-egg-producing flocks.

Artificial light and automatic water supply should be installed.

The Folding System. This system of poultry-keeping has been practised for many years. In the early 1920s it attracted the attention of certain general farmers and specialist poultrymen, who applied it on a commercial scale.

In the course of about ten years a large number of farmers adopted the system, which enjoyed something in the nature of a boom from about 1930 until the outbreak of war in 1939.

The advantages may be summarized as follows:—

(1) The birds are kept in small flocks.

(2) They are moved to fresh ground daily.

(3) They are under the complete control and close observation of the attendant.

(4) In the event of an outbreak of disease, affected units can be isolated.

(5) Owing to constant movement to fresh ground, the danger of worm infestation and coccidiosis is remote.

(2) The need to move the folds every day.

(3) Depreciation of folds is heavier than that of fixed houses.

(4) It is unsuitable for hill farms or those subject to heavy falls of snow.

(5) Lower average winter egg production.

(6) High percentage of soiled eggs in wet weather. Egg cleaning occupies considerable time on commercial plants.

Since the late war the price emphasis on winter egg production has caused the system to lose much of its popular appeal.

Some, but by no means all, economic studies show that the financial returns from fold units do not compare favourably with those from flocks kept on more intensive systems.

Nevertheless, the general farmer running folds over his grassland is not concerned with egg production only. He may be satisfied with a lower direct profit from his poultry, knowing that he will receive an indirect profit in the improvement of the grass.

The effect of folding poultry over grass of poor quality is remarkable, and may more than compensate the farmer for lower winter egg production.

The level of winter production largely depends on the weather. In a mild winter a high output can be maintained, but in the event of a spell of severe frost or a heavy fall of snow of long duration, production may slump badly, and many of the birds may moult. Such an occurrence would be serious for those dependent or largely dependent on their laying flocks.

In winter, egg-cleaning adds to the cost of fold management, and it is not a task that appeals to the intelligent worker.

Shaw and Nightall (1952) found that with fold units in which the average number of birds was 850 from 1½ to 2 hours daily were required to complete egg washing and packing. Ninety per cent of the eggs required cleaning most of the year with a reduction to 35 per cent under the best conditions.

The time occupied in this work is reduced appreciably by the use of an efficient egg-cleaning machine.

The folding of poultry should not be attempted on hill farms, or in districts where the snowfall is heavy. Level, or at least undulating, land that is well drained is essential for the success

The all-wire and slatted-floor housing systems seem destined to find a place in poultry production. On some holdings the deep-litter system is not a success; moreover, in many areas litter is in short supply and is costly.

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(4) In the event of an outbreak of disease, affected units can be isolated.

(5) Owing to constant movement to fresh ground, the danger of worm infestation and coccidiosis is remote.

(6) No fences are required.

(7) Wild birds cannot consume or contaminate food.

(8) The houses need not be closed at night.

(9) It is a very convenient method of housing on the general farm where poultry take their place in the farm's rotation.

(10) It ensures uniform distribution of the manure.

(11) The scratching and treading of the birds are spread over the whole field.

(12) The same house may be used for all classes of poultry.

Among the disadvantages may be mentioned:—

(1) The relatively high cost of housing compared with free range.

(2) The need to move the folds every day

(3) Depreciation of folds is heavier than that of fixed houses

(4) It is unsuitable for hill farms or those subject to heavy falls of snow

(5) Lower average winter egg production

(6) High percentage of soiled eggs in wet weather Egg cleaning occupies considerable time on commercial plants

Since the late war the price emphasis on winter egg production has caused the system to lose much of its popular appeal

Some, but by no means all, economic studies show that the financial returns from fold units do not compare favourably with those from flocks kept on more intensive systems

Nevertheless, the general farmer running folds over his grassland is not concerned with egg production only He may be satisfied with a lower direct profit from his poultry, knowing that he will receive an indirect profit in the improvement of the grass

The effect of folding poultry over grass of poor quality is remarkable, and may more than compensate the farmer for lower winter egg production

The level of winter production largely depends on the weather In a mild winter a high output can be maintained, but in the event of a spell of severe frost or a heavy fall of snow of long duration, production may slump badly, and many of the birds may moult Such an occurrence would be serious for those dependent or largely dependent on their laying flocks

In winter, egg cleaning adds to the cost of fold management, and it is not a task that appeals to the intelligent worker

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The time occupied in this work is reduced appreciably by the use of an efficient egg-cleaning machine

The folding of poultry should not be attempted on hill farms, or in districts where the snowfall is heavy Level, or at least undulating, land that is well drained is essential for the success

of the system. Land that becomes waterlogged during the winter months is totally unsuitable. Light or medium soils are preferable to heavy soils. Heavy clays retentive of moisture are undesirable, although the system has been applied successfully on some of the heaviest land in the country.

The number of birds that may be kept per acre on this system depends on the quality of the ground, but more especially on its condition during the winter months. Some very optimistic estimates have been given, usually based on spring and summer

Photo: Modern Poultry Keeping

FIG. 8—THE FOLD SYSTEM

A section of a group of folds housing about 900 layers. The folds are moved forward daily, the second row occupying the ground previously between the folds in the first row

folding, when the stock-carrying capacity of the land is at its maximum.

Where a field, well drained, reasonably level and free from obstructions such as trees, is used exclusively for folding poultry, up to 300 birds may be kept per acre, though it would be unwise to consider this a normal rate of stocking.

For all-the-year-round work, conditions in the winter months become a limiting factor. Unless circumstances are particularly favourable, 200 birds per acre would be sufficient for the land to carry. This means that each plot of ground would be occupied about ten times in the course of the year, or say once every five weeks.

On the general farm the farmer rarely thinks in these terms. He may have, say, twenty-five or fifty units (twenty birds per unit), and all are moved from field to field, taking their part in the farm's rotation. In this way the folds may pass over a given field only once in three or four years.

Labour. Despite the need for moving the folds daily, the system does not make undue demands on labour, although of course the straw-yard and the deep-litter systems enable a man to look after a greater number of birds.

A competent man wholly employed on the job can take charge of 1,500–2,000 birds, if the folds are arranged as a unit—*i.e.*, if they are in the same field or adjacent fields, and food and water are at hand. He cannot, however, manage so many birds if he has to spend a considerable part of the day carrying food and water, or if he is expected to undertake odd jobs. His duties should include feeding and watering, moving the folds, collection (but not packing) of eggs, culling and repair of plant.

On large farms water should be laid on to the fields, or, if this is not possible, it should be carried in bulk by horse or tractor. Subsidiary food stores should be used in the field. A portable solid-floor poultry-house will fulfil this purpose very well. In order to save "walking time" it can be placed in the centre of a row of folds and be moved with them across the field.

Long daily hauls of food and water must be avoided if labour costs are not to prove disproportionately high.

In order to avoid many of the disadvantages of this system, some producers have made fold compounds near the farm buildings.

The fold units are mounted on wood or concrete supports about 2 ft. or 2 ft. 6 in. from the ground, the run section of the units being fitted with a wire floor.

On some farms the compounds are flood-lit during the winter months to give the birds a 13- or 14-hour day.

Static folds are also used for table-poultry production, the chicks being moved from the brooder house when they are about 6 or 8 weeks old.

When folding is practised during the winter the units are littered with straw if they cannot be moved owing to snow.

Larger folds which comprise a small slatted-floor house or slatted roost with nests which can be fitted with trap-nest fronts have separate run sections, one or more being coupled to the house. The complete unit is drawn forward by tractor.

On heavy land, folds of this type are grouped together and the runs littered with straw in the winter. They remain on the winter site until the land dries in the spring, when they are again used as portable units. In winter additional run sections may be used. The litter is built up to a depth of 6–10 in. It is distributed when folding is resumed.

Breeding in Folds. Free range or an extensive run is so frequently advised for breeding stock that the question of breeding from birds confined in folds naturally arises.

In view of the experience of a large number of breeders, it can be stated that the system is entirely successful for this purpose, and no one need hesitate to adopt it. Nevertheless, it should be pointed out that some prejudice exists against the system for breeding stock, and more than one breeder has reverted to more orthodox methods in deference to his customer's wishes.

Many prospective customers visiting farms like to see the stock on range or in large grass runs, and their opinion must weigh with the breeder. There is, however, no evidence that the folding system of housing has any adverse effect on the stock.

To meet the wishes of customers, some breeders confine the birds to folds except during the actual breeding season, when they are given their liberty, the fold being used merely for roosting and laying. In such circumstances, the units should, of course, be placed well apart to prevent the flocks becoming mixed.

On some farms where breeding in folds is carried out the male birds are rotated from fold to fold. This assists in securing very high fertility, since it solves the problem that arises when males do not mate with certain hens.

Static Laying Units. While the folding system has no longer wide appeal, static laying units are popular. Some large plants are now equipped with them. They are, of course, equally suitable for the small-scale producer.

Each unit comprises a small house and wire or slatted-floor

balcony the whole being raised about 2 ft. 6 in. from the ground.

The house is usually about 6 ft. 6 in. × 4 ft. 6 in., with lean-to roof providing head room of about 3 ft. 6 in. at front eaves, 2 ft. 9 in. at rear eaves.

Balcony is usually about 10 ft. × 6 ft. 6 in. × 2 ft. 6 in. from floor to top. Some units have covered balconies.

Food troughs are arranged along each side of the balcony and a water trough at one end.

Nest-boxes are built into the house section. In some units

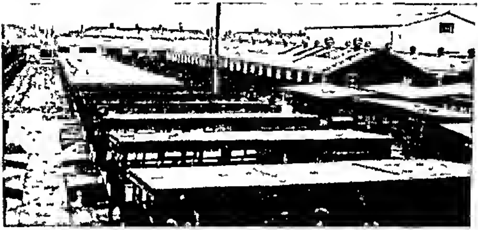

Photo Poultry Farmer and Packer

FIG. 8A —STATIC REARING AND LAYING UNITS WITH BATTERY HOUSES IN THE BACKGROUND

An example of concentrated production in a small area

the whole of the roost section is in essence a large battery laying cage. The floor is of 16-gauge, 1-in. mesh wire netting sloping gently to the back of the house from where the eggs are collected.

A unit of the above dimensions will house up to seventy light breed or sixty heavy breed pullets. It is equally suitable for growing stock.

Grouped together with hard paving between the units, they provide a compact section in which a large number of birds can be kept on a small area.

So arranged it is a simple matter to provide artificial light for laying stock. One 100-watt lamp in the balcony and a 15-watt lamp in the house section will be adequate, the house

lamp being used merely to attract the birds to the roost before the balcony lamp is switched off. All units can be wired to a common switch.

The Battery System. The battery system of egg production means keeping layers in one-, two- or three-bird cages arranged in one or more tiers, in single or double rows—*i.e.*,

Photo Modern Poultry Keeping

FIG. 9—THE BATTERY SYSTEM INTERIOR OF A BATTERY LAYING HOUSE

back to back It may be described as the super-intensive system.

Cages with adjustable partitions providing for up to six birds per cage are now available.

When first introduced about 1933 it received a very mixed reception. Many said it was an impracticable method of keeping laying stock, others visualized the creation of mammoth "egg factories" where birds would be kept in enormous numbers, producing eggs so cheaply that the commercial poultry-man working on orthodox lines would be forced out of business These proved to be extreme views and, as usual, the truth lay between them. The system made rapid progress from the time of its introduction until the war prevented further development.

After the war, when manufacturers resumed production, batteries of diverse types became a feature of shows and poultry-housing demonstrations

The battery has proved an economic system of egg production, very large plants have been erected in recent years, some for several thousand birds on holdings of a few acres Two- and three-bird cages are becoming increasingly popular

Undoubtedly the high capital cost of the system deters many from investing in batteries Looking at the problem purely from the business standpoint, however, return on capital is of primary importance, and a simple calculation will show that, compared with other systems, a battery plant need produce very few extra winter eggs to yield a satisfactory rate of interest at current prices

Taking a 1,008-cage plant as a unit, the cost to-day works out at about £1,250, and if no building is available the cost of housing the cages will be in the region of £1,000

If the cages are arranged in two double blocks of three tiers parallel to the length of the building, a house about 120 ft. × 18 ft will be required, allowance being made for service passages The actual size will depend on the type of cage This is equivalent to about 2 2 sq ft of floor area per bird, or about half that required for birds housed intensively on the floor.

On this basis the cost of house and cages is about 44*s* per bird which is high compared with say, 16*s* to 20*s* for solid floor houses, 15*s* to 16*s* for slatted floors and 20*s* to 25*s* for folds

Very substantial economy can be effected in the cost of a battery plant by the installation of multiple-bird cages and in housing by having four-tier cages instead of the usual three-tier.

Assuming, however, that the capital cost of the battery plant (including house) is 30*s* per bird greater than that of other systems and 5 per cent interest and 15 per cent depreciation are charged on the additional capital, a return of 6*s* per cage will meet the additional charge or about 13 winter eggs at the present prices In a well-managed battery the average winter egg production should be more than sufficient to pay the extra capital charge

Profit per bird, however, is not necessarily a measure of profitability from the poultry project From the business standpoint the producer is concerned with the return on capital

investment; that being so, although the profit per bird from batteries may be higher than from flocks on deep litter or yards, the greater number of birds that could be housed on the latter systems compared with the battery system employing the same capital may provide greater profit.

Successful management of flocks on deep litter and yards demands greater skill than is required to ensure high average egg production from birds in cages, and for this reason many find cages more profitable, notwithstanding the higher capital outlay. But it cannot be said that the battery system is invariably the most profitable. Profit depends on many variable factors.

Single-bird cages are usually 14–15 in. wide, *i.e.*, from side to side, but they are sufficiently roomy for two birds per cage, in fact a number of battery owners have doubled the capacity of their plants, reducing capital expenditure per bird by 50 per cent by this simple procedure. Others economize by installing single-bird cages 10 in. wide.

Standard twin-bird cages are usually about 17 in. wide, although three or four birds may be kept in them.

Laying batteries are becoming more and more mechanized, many clever ideas having been adopted to reduce the cost of labour.

The advantages of the system may be summed up as follows:—

(1) Complete control of the birds.

(2) Accurate records of egg production are ensured by the single cage, which in effect provides automatic trap-nesting.

(3) Absence of feather-plucking and cannibalism.

(4) Egg-eating is largely prevented.

(5) No bullying or interference when the birds are feeding. Thus every bird can feed in comfort and can have all the food it wants.

(6) No contamination of the food and water with droppings, thus preventing the spread of disease by this means.

(7) The wire floors prevent re-infestation with worms and coccidia.

(8) High average egg production. The average egg production of birds in cages is usually higher than that obtained with any other system. This is attributable to the prevention of bullying, freedom from internal parasites and good environmental conditions that ensure proper assimilation of the food.

(9) Culling (the removal of unprofitable birds) is simplified. With the production record of every bird kept up to date on a card attached to the cage, the battery owner can get rid of unprofitable birds before they have eaten up the profits from good layers.

(10) Litter is not required.

(11) Weather conditions have very little effect on battery egg production.

(12) Immediate removal of sick birds.

(13) Birds of different ages may be kept if necessary in adjacent cages. Replacement of birds can be carried out at any time without causing disturbance in the "flock".

(14) The attendant works under comfortable conditions at all seasons.

(15) He may work ordinary business hours.

(16) A very large number of birds may be kept on a small plot of ground. By adopting the battery system for layers and the intensive system for chicks and growing stock it is possible to maintain some 5,000–6,000 layers and rear the necessary replacement stock on one acre of ground. But such a high concentration of birds is inadvisable owing to the greater danger of disease it entails. Moreover, chicks should not be housed in very close proximity to adults. About 2,000 layers and their replacements per acre would be a more reasonable and safer estimate.

(17) Eggs are collected in clean condition.

(18) Birds confined to batteries are tender and realize good prices for the table.

(19) It is the ideal system for the domestic poultry-keeper and part-time poultry-man.

Other factors being equal, the domestic poultry-keeper would secure far higher returns with this system than with any other. Attention at regular hours is unnecessary. He could maintain his little flock practically at full strength

throughout the year With food and water available he could, if desired, leave the birds unattended for the week-end

The part-time poultry-man could make a start with a few cages and gradually extend his plant until he had, say, 1,000 layers This means that he could begin to build up his poultry business while continuing his normal employment

(20) The novice is more likely to make a success of this system of poultry-keeping than of any other. It is not fool-proof, but the beginner who is contemplating taking up batteries on a commercial scale could learn more about the system in six months than he would about other systems in two or three years

(21) In sheltered situations outdoor batteries may be employed, thus saving the cost of housing

Some of the above advantages call for comment

In multiple-bird cages it is impossible to keep individual records This is not a matter for concern, because should egg production be low, handling and observation will reveal birds not in lay or individuals likely to be poor producers The condition of the droppings is of considerable significance

Even in single-bird cages on large plants continuous recording of individuals is not considered worth while Records may be kept only for short periods at certain seasons

But on many plants no cage recording is undertaken at any time It is common practice to record the eggs from each block or section of cages, the birds concerned being regarded as a flock to be culled when they cease to lay a profitable number of eggs over a given period of perhaps seven to fourteen days

The actual period will depend on previous performance and on the time the birds have been in the cages If production declines below the profit point a few weeks before the birds are due to be marketed they should be sold at once On the contrary, a fall in output after a short time in the cages is probably temporary, and they should be given an opportunity of improving their output

Feather plucking and cannibalism may occur in multiple-bird cages, as it may in single cages if they are not well designed

The batteryman should be ready to deal with these vices. Paring the beak (de-beaking) is the best treatment.

One man can attend to 2,000–2,500 layers in single-bird cages of modern design, 5,000 or so in multiple-bird cages if fully mechanised and a system of block egg recording is adopted. Individual cage recording increases labour costs very substantially.

Poultry-farm Lay-out. Poultry-farm lay-out requires much more thought than is usually given to it, or so it would appear from the lack of planning that is only too evident on many farms.

Some poultry-men speak with pride of the number of miles they walk in a day's work. Whether or not this is good for their health only a medical man could decide, but it is not good for business. If in the ordinary course of routine the poultry-man is compelled to reduce himself to a state bordering on exhaustion he may be assured that his farm is badly planned.

On many farms in this country very many poultry-houses of various shapes and sizes are placed here and there, with no regard to labour costs. Much of the trouble arises from the original plan being on too small a scale.

Frequently a man starts business with the object of building up a flock of about 2,000 layers. His farm is laid out for this purpose. In the course of a few years, however, he may wish to extend, or perhaps he may desire to enter the pedigree breeding field, not contemplated when he made a start. He finds that the land most convenient for this purpose is already occupied by his original buildings. Complete reorganization of a farm is an expensive procedure, and he therefore decides to erect houses in the more outlying parts of his farm. More often than not this results in complete disorganization, and he pays the penalty for the rest of his life. It becomes a permanent charge on his business.

The writer has visited farms where additional trap-nest houses have been erected far from the central buildings, where several parts of the farm are used for chicken-rearing—where, in fact, it is impossible to systematize the work to effect economy in labour.

The prospective poultry-farmer should bear in mind the question of expansion when laying out his farm, or he will probably fall into the trap of over-concentration.

Actual lay-out must, of course, depend on the size of the farm, the system of poultry-keeping it is proposed to adopt, and the branch of the industry in which it is intended to specialize.

The table-bird producer working on intensive lines and the battery-egg producer obviously require their farms to be laid out according to plans very different from those suitable for the breeder, the pullet-rearer and the man who adopts extensive methods of egg- or table-poultry production.

While every farm must be considered individually, there are nevertheless certain broad principles that should be applied.

It is most desirable, for example, to have the office and incubator house within easy reach of the residence. Brooder houses, too, should be erected in the "home" fields, where they will be most convenient for inspection. Trap-nest houses should be placed in the "inner circle".

Farther afield the commercial layers and untrapped breeders should be housed and beyond them the growing stock, assuming that the birds are reared extensively.

Further, in all instances where the land is occupied by the birds, arrangements should be made whereby alternative ground is available without involving considerable expenditure. This is not very difficult provided a little forethought is given to the problem.

"Walking time" represents a major labour outlay on all farms run on extensive or semi-intensive lines. That being so, every endeavour should be made to reduce to a minimum the time occupied in this unproductive work.

Although labour costs must be considered, the primary purpose of farm planning should be to provide the most favourable conditions for the stock. The farmer is the owner of his birds, but they are his master in the sense that he must consider their comfort and well-being before his convenience.

If the general principles already outlined are kept in mind, there should be little difficulty in deciding on a convenient lay-out for the farm.

By way of example, assume that a farm of 20 acres has been purchased, and it is proposed to keep about 1,000–1,500 layers and to breed the replacements at home. When the farm is established, the owner will turn his attention to selling chicks and stock birds.

He decides to rear the chicks intensively for the first four weeks, when they will go into hay-box brooders on range. Some of the adult pullets are to be kept in portable houses in large runs, and will be used for cross-breeding: others will be kept in batteries or on the deep-litter system. The pedigree breeding stock will be housed in small flock-houses having alternate runs.

Experienced poultry-men may criticize these proposals on account of their lack of originality. In this they would be justified, but these proposals, admittedly orthodox, are the broad outline of plans many successful poultry-farmers have adopted.

Assuming that, with the exception of the residence, there are no buildings on the farm, the lay-out may be similar to that represented on the following plan:—

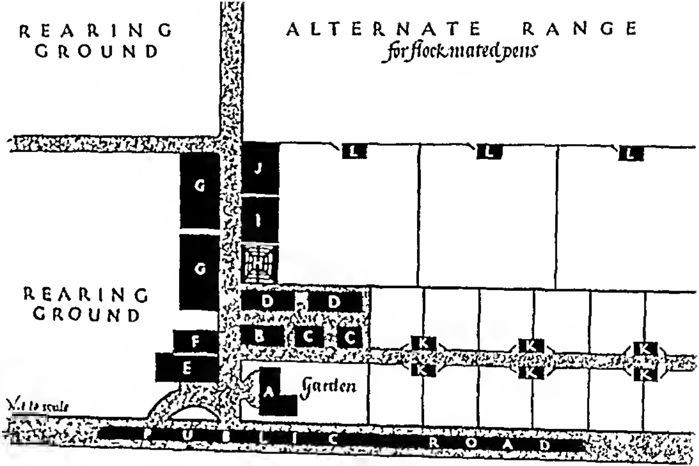

FIG. 10.—PLAN OF SPECIALIST POULTRY-FARM

A Residence
B Office and Incubator Room
E. Granary.
F. Poultry and Egg Store
G Battery or Deep-litter Houses
H Washing Yard.
I. Workshop
J. Open Shed.
K. Breeding Pens
L. Flock-mated Pens

Chapter Four

Utility Breeds of Poultry

THE number of breeds and varieties of breeds of fowls is large The majority are of interest only for exhibition purposes, few are of value to the commercial producer, and of these only about eight occupy a prominent position in the industry The industry has, in fact, been built up on these breeds and their crosses

From time to time certain breeds receive much publicity in the poultry Press, their breeders giving glowing accounts of the wonderful qualities the birds are said to possess The poultry-farmer should not be misled by other people's enthusiasm for their favourite breed Such statements as "this is the coming breed for commercial purposes, it is the perfect dual-purpose fowl" should be accepted with reserve Should he believe that a new breed or new variety may become of economic importance, he should invest in one or two pens in order to gain first-hand experience and to assess public demand

Many breeds have enjoyed short lived popularity in a very limited circle, and a man may easily "burn his fingers" by taking up a breed on an extensive scale before it has proved its worth on the farm

The poultry-man dependent on his birds for his living should select breeds or crosses that are kept by others in a similar position, and disregard the claims of newer breeds until his business is well established He may be assured that the popular commercial breeds that constitute the stock in-trade of the poultry-farmer have earned their popularity They are breeds of real economic value on which he may rely for a fair return under good management

The beginner who wishes to become a pedigree-breeder should choose one breed and devote his time to it rather than divide it between two or more breeds

He will find that one breed will provide him with plenty of work and scope for his skill and enterprise for many years. Probably when he has established his own strain he will not wish to introduce other breeds, especially if he hopes one day to become a pedigree-breeder of high repute. However, when he has reached his first objective he will have gained sufficient knowledge and experience of breeding and the business side to judge whether or not a second breed is desirable.

More rapid progress will be made in stock improvement by working with one breed. Demand for cross-bred stock can be met by the introduction of cockerels from a breeder of high standing in the industry, and if his stock proves to produce superior crosses, cockerels should be purchased from him each year.

This policy of specialization in one breed is advised not only for beginners but also for all breeders operating on a small scale.

A measure of the commercial importance of the utility breeds is obtained from the number of entries in the laying trials.

The following tables show the representation of the breeds at three of the principal trials, 1958–59:—

TABLE 11 (*contd*)

Poultry Production and Progeny Trials

Breed	1958 59 Parent Test			Progeny Test (progeny of 1957 58 parent stock)		
	No of entries	Average egg production	Mortality %	No of birds	Average egg production	Mortality %
Rhode Island Red	516	230.43	9.69	840	192.75	20.12
Light Sussex	312	213.14	8.65	560	200.44	11.43
Buff Rock	36	215.83	11.11	60	187.70	13.33
New Hampshire Red	12	191.25	—	20	177.10	20.00
North Holland Blue	12	198.42	—	—	—	—
White Leghorn	156	214.86	13.46	220	182.45	15.45
Black Leghorn	60	184.57	26.67	100	180.92	15.00
Brown Leghorn	120	191.53	6.67	100	166.45	14.00
Ancona	12	171.75	25.00	20	88.70	20.00
	Average egg production 216.4 per bird			Average egg production 190.44 per bird		

It will be noted that the Rhode Island Red is the supreme commercial breed of the day. Other breeds fall far behind it numerically. The Sussex, principally the Light variety, is its nearest rival in heavy breeds, followed by the White Wyandotte, Buff Rock, North Holland Blue and New Hampshire Red.

Among light breeds the White Leghorn holds pride of place. Its status has improved enormously in recent years, superior strains being in great demand for crossing.

The Brown Leghorn is also favoured for crossing, usually with the Light Sussex and Rhode Island Red, but as a pure breed it is not so widely kept as the White variety.

The Black Leghorn has lost much of its former popularity due to the increasing preference for white or light coloured birds for commercial production.

These breeds and their crosses fulfil the requirements of the majority of pedigree breeders and commercial producers, and the beginner will do well to select from this short list the breed he intends to take up.

The term breed, however, *is losing much of its significance* in commercial circles. Newer systems of breeding for the production of so called hybrid strains have resulted in a movement away from breed names in the description of cross

bred poultry to strain names or numbers. This matter is discussed in Chapter Seven.

Heavy Breeds (Commercial). *The Rhode Island Red.* This is an American breed that, as far as can be traced, was the result of mating the Red (Partridge) Cochins and Malays with the common fowl of the district. About 1891 they were exhibited at Philadelphia under the name of Golden Reds. Ten years later a standard was established for the breed and a Club was formed in its interests. It was admitted to the American Standard in 1904.

The Rhode was introduced into Britain at the end of last century, but was kept largely for exhibition by a few breeders. About 1910, however, the breed began to make headway on the show bench and in the utility field, and demonstrated its economic qualities at laying trials. Since those early days it has made continuous progress, and now occupies the most eminent position among commercial fowls. This it has achieved on account of its great stamina and productive ability.

The body is long, broad and deep, and the tail is carried rather low. The plumage is short, tight and glossy. Colour in utility strains is very variable. The breed standard demands a brilliant rich red, but perhaps it is needless to add that the majority of utility strains cannot claim to conform to the colour demanded on the show bench.

At one time many commercial strains were of very poor colour—rather brown than red. In recent years considerable improvement has been effected.

To what extent utility strains should be bred for colour is a highly controversial subject, not within the province of this work to discuss. As in other commercial breeds, good health and all that it implies, and high production must be maintained, so that it would be unreasonable to insist on the rich red plumage in the light of existing knowledge of genetics. Nevertheless, unless the breed is to lose its identity, breeders cannot afford to ignore the colour factor.

The Rhode has yellow flesh and legs and a high breast-bone. For these reasons it is not a first-class table fowl. The standard weights are: cock 8½ lb., cockerel 8 lb., hen 6½ lb., pullet 5½ lb.[1]

[1] For this and other breeds average weights of birds of commercial quality is usually rather below the standard weight. The latter refers to the Poultry Club Standards.

There are both single- and rose-comb varieties, but the latter was never popular. The deep-tinted brown eggs are of excellent size and texture

The Rhode Island White was admitted to the American Standard in 1922. Although white plumage is a desirable feature, the variety has attracted little attention in this country

The White Wyandotte The White Wyandotte is a sport of the Silver-Laced Wyandotte and, as its name implies, it originated in America

The first specimens of the Silver-Laced are believed to have been the result of crossing a Sebright Bantam and a Cochin hen Subsequently Dark Brahma and Silver-Spangled Hamburgh were crossed with the progeny of the first mating

When first introduced in America and Britain the Silver-Laced, although an attractive variety, did not make a wide appeal, and it was not until the advent of the White that real progress was made.

With the coming of the White variety the breed quickly attained a position of importance Although some strains laid small eggs—attributed to the influence of the Sebright Bantam —it was a prolific layer, and for some years shared with the White Leghorn the premier position among commercial breeds Together it may be said that they were the two breeds on which the poultry industry was founded

Some thirty years ago the White Wyandotte was ubiquitous, being found on almost every poultry-farm Unfortunately, its popularity was the cause of its decline Newcomers to the industry almost invariably bred White Wyandottes, and they bred for egg production, while ignoring stamina The result was that it began to deteriorate, and no very great effort was made to arrest its decline and repair the damage that had been done Instead, the majority of breeders discarded it in favour of the Rhode, then coming to the fore

To-day the breed occupies a comparatively low place among commercial breeds This is regrettable, because in its hey-day it was second to none as a layer and far superior to the Rhode as a table bird

The Wyandotte is shorter and more rounded in the body than the Rhode It has what is known as a "cobby" appearance

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The Rhode was introduced into Britain at the end of last century, but was kept largely for exhibition by a few breeders. About 1910, however, the breed began to make headway on the show bench and in the utility field, and demonstrated its economic qualities at laying trials. Since those early days it has made continuous progress, and now occupies the most eminent position among commercial fowls. This it has achieved on account of its great stamina and productive ability.

The body is long, broad and deep, and the tail is carried rather low. The plumage is short, tight and glossy. Colour in utility strains is very variable. The breed standard demands a brilliant rich red, but perhaps it is needless to add that the majority of utility strains cannot claim to conform to the colour demanded on the show bench.

At one time many commercial strains were of very poor colour—rather brown than red. In recent years considerable improvement has been effected.

To what extent utility strains should be bred for colour is a highly controversial subject, not within the province of this work to discuss. As in other commercial breeds, good health and all that it implies, and high production must be maintained, so that it would be unreasonable to insist on the rich red plumage in the light of existing knowledge of genetics. Nevertheless, unless the breed is to lose its identity, breeders cannot afford to ignore the colour factor.

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[1] For this and other breeds average weight of birds of commercial quality is usually rather below the standard weight. The latter refers to the Poultry Club Standards.

There are both single- and rose comb varieties, but the latter was never popular The deep-tinted brown eggs are of excellent size and texture

The Rhode Island White was admitted to the American Standard in 1922 Although white plumage is a desirable feature, the variety has attracted little attention in this country

The White Wyandotte The White Wyandotte is a sport of the Silver-Laced Wyandotte and, as its name implies, it originated in America

The first specimens of the Silver-Laced are believed to have been the result of crossing a Sebright Bantam and a Cochin hen Subsequently Dark Brahma and Silver-Spangled Hamburgh were crossed with the progeny of the first mating

When first introduced in America and Britain the Silver-Laced, although an attractive variety, did not make a wide appeal, and it was not until the advent of the White that real progress was made

With the coming of the White variety the breed quickly attained a position of importance Although some strains laid small eggs—attributed to the influence of the Sebright Bantam—it was a prolific layer, and for some years shared with the White Leghorn the premier position among commercial breeds Together it may be said that they were the two breeds on which the poultry industry was founded

Some thirty years ago the White Wyandotte was ubiquitous, being found on almost every poultry farm Unfortunately, its popularity was the cause of its decline Newcomers to the industry almost invariably bred White Wyandottes, and they bred for egg production, while ignoring stamina The result was that it began to deteriorate, and no very great effort was made to arrest its decline and repair the damage that had been done Instead, the majority of breeders discarded it in favour of the Rhode, then coming to the fore

To day the breed occupies a comparatively low place among commercial breeds This is regrettable, because in its hey-day it was second to none as a layer and far superior to the Rhode as a table bird

The Wyandotte is shorter and more rounded in the body than the Rhode It has what is known as a "cobby" appearance

Although its flesh is yellow, it has not the depth of pigment of the Rhode, and given a suitable diet a white-fleshed bird is easily produced for table. It has a more compact frame and lower breast-bone than the Rhode. It has a rose comb. Some individuals, however, are not pure for this factor, and a variable proportion of single combs may appear from certain matings. The single comb is a breed defect, and such birds should not be used for pure breeding, although they are quite suitable for crossing.

The breed—or many strains of it—is handicapped on account of low fertility. There is no doubt that, broadly, the Wyandotte is not so fertile as other popular breeds, but despite the fact that the inheritance of fertility is extremely low, it is probable that careful selection would effect improvement, if only for the reason that it would improve vigour. Some breeders have succeeded in maintaining high fertility in their strains.

In common with other commercial breeds, the Wyandotte has suffered at the hands of the novice and the extremist. Body-weight is far from satisfactory in some strains, and birds that bear the stamp of the Leghorn are not uncommonly seen.

Whether or not the breed will ever regain its former position in the industry is doubtful. At present there is no evidence of its revival. The industry will be poorer if it allows this famous breed to pass into oblivion.

The standard weights for the breed are: Cock 8–9 lb., cockerel 6½–7½ lb., hen 7 lb., pullet 5½ lb.

The breed lays tinted eggs.

Other varieties of the Wyandotte are the Gold-Laced, Buff-Laced, Partridge, Silver-Pencilled, Black, Columbian, Blue, Blue-Laced and Red. None of these varieties is of value to the commercial breeder.

The Light Sussex. The Sussex is a British breed, the Light variety being the most popular. It has been bred in the south-eastern counties of England for a great many years, largely for the production of table-poultry, its excellence for this purpose being unsurpassed.

It is closely related to the Dorking—indeed, about a hundred years ago a variety of this breed in which the fifth toe was absent was known as the Sussex or Surrey fowl.

Bred for many years for its table qualities, in comparatively

recent times it attracted the attention of the pedigree breed who quickly created the modern Light Sussex—the t utility fowl

The egg production of the leading strains of this variety n compares favourably with that of other breeds A pullet fl average of about 180 eggs per bird may reasonably be ex pected From some strains the output exceeds 200

When the table type of Sussex was first bred for egg produc tion there was a marked tendency to loss of body size Some of the pens entered in the laying trials showed the effect of breeding for egg production The birds were small and far from being the true Sussex type

Fortunately, breeders were aware of the danger confronting them, and it is to their credit that the quality of the stock has been improved in recent years Some strains, however, are far below the Sussex standard, indeed some of the birds could not be described as true Sussex, since in body conformation they resemble crosses with the light breeds

The Sussex Club has done sterling work in safeguarding the interests of this famous breed The Club has made every effort to discourage breeders from creating the small bodied "sprinter" type and breeding for exaggerated exhibition points—a policy that has resulted in certain other breeds falling out of favour The Club's standard for the breed is one with which the utility breeder can, and indeed must, conform if he is to retain his position among Sussex breeders

The body of the Sussex should be long and deep, with a flat back and long, straight breast It should be a big bird, although not coarse or too long in the leg

The body colour should be pure white, with black only in the neck hackle, wings and tail The skin should be white and of fine texture The eggs are tinted and of good average size The breed has a single comb of moderate size The standard weights are Cock 9 lb and upwards, hen 7 lb and upwards

In addition to the Light, there are the following varieties Red, Speckled, Brown, Buff and White, of which only the White is of economic importance

This variety is a "sport" of the Light, and is already favoured by a number of poultry farmers It should attain a more prominent position in the industry, as it has all the qualities of

the Light, and satisfies the requirements of those looking for a first class general purpose fowl Being devoid of markings, the breeder is not tempted to select for the finer breed points, as far as feather is concerned He can concentrate on shape, size and productive ability

The White Sussex, in common with the Light, should be pure for the silver factor, and therefore give sex linkage when mated with "gold" males

Some strains are impure for this factor and will cause confusion when sexing day-old chicks The breeder contemplating introducing this variety should be assured that he is purchasing a strain pure for silver

The Plymouth Rock This is an American breed, believed to have been produced by crossing the American Dominique and the Black Cochin Investigation, however, suggests that other breeds were concerned with its evolution, and that there were several distinct lines or families

It is said that four lines were united about 1878, resulting in the Rock, which has taken its place in the ranks of the utility breeds

The Barred Rock The Barred Rock, for many years one of the most popular varieties in America and especially in Canada, no longer holds this position on account of the colour of the crosses with the breed As in Great Britain, there is increasing demand for white or light coloured crosses, both for table poultry and egg production

A number of British breeders have imported Canadian strains Some have crossed them with British strains, but it is quite evident that the two varieties are distinct

In Canada some remarkable records of egg production have been obtained under the Record of Performance (R O P) scheme of the Canadian Government

There is considerable difference between the Canadian and British type, the former being essentially a utility bird while the latter is most commonly seen in the exhibition pen

In Britain the breed has failed to gain great popularity, although there have been a number of excellent pens entered in laying trials

The Barred Rock is the basis of the auto-sexing breeds and some breeders became interested in it on this account But

will be created.

The Rock is a large, rather tall fowl, with a deep, long and squarely built body. It possesses an abundance of bone, and fineness in this respect should not be permitted in the breeding-pen.

The barring should be uniform throughout, with a greyish under-colour.

Compared with the more popular utility breeds, it cannot be said that the Barred Rock is a prolific layer, as a perusal of laying-test reports will show. Moreover, in some strains egg-size leaves something to be desired.

Having regard to modern trends, it cannot be said that the variety has a bright future. It has little to offer the breeder of commercial stock.

Standard weights: Cock 9–10 lb., cockerel 7½–9½ lb., hen 7–8 lb., pullet 6–7 lb.

The *Buff Rock* has always enjoyed popularity as the farmer's fowl on account of its hardiness and utility qualities. It is a first-class dual-purpose variety that has made considerable progress in recent years, thanks to the attention given to it by some of our leading pedigree-breeders. It is a breed that should be kept by many more poultry-farmers. It deserves to be more popular. A good strain will give an average egg production equal to or better than many other breeds that have received greater publicity, while, despite its yellow skin and legs, it provides an excellent bird for the table, even if it cannot be described as first-class material for those markets in which a premium is paid for white flesh.

As its name implies, this variety should be buff throughout—a golden buff, not the pale, washed-out colour seen in some strains.

Other varieties of the breed are the White, Silver-Pencilled, Partridge, Columbian and Blue. With the exception of the White all these are, however, purely exhibition varieties; they are not bred for utility purposes.

The White Rock This variety, used extensively in the United States and Canada for the production of special table-poultry (broiler) strains, has recently assumed considerable importance for the same purpose in this country

Certain breeders catering for the table poultry producer are using the White Rock for crossing with meat strains of Sussex, New Hampshire Red and Indian Game crosses It is also one of the breeds used in the production of special meat type strains of cockerels for mating with flocks for the production of table chicks

Strains differ widely in quality, both with regard to body conformation and ratio of meat to bone

Dominant white strains have been developed Their superiority for table poultry production is patent

But not all strains offered as dominant white are pure for this character Care should be exercised in choosing a source of stock, for some White Rocks produce quite an amazing variety of coloured birds among their cross bred offspring

The Orpington The Orpington was originated by the late William Cook, of Orpington, Kent He mated Minorca cocks with Black Rock hens and the progeny of this cross with clean legged Black Langshans Thus produced the Black Orpington The original breed was of great utility value, but the introduction of Cochin blood for the purpose of increasing the size of the breed resulted in the loss of its commercial qualities

The Australorp—the original Black Orpington—was exported to Australia where it gained a high reputation in the laying trials The breed has since been brought back to its native land, but has failed to gain popularity

To day the Black Orpington is essentially an exhibition fowl, large, coarse in bone, and slow to mature

The Buff Orpington which William Cook claimed to have evolved from Gold Spangled Hamburghs Dark Dorkings and Buff Cochins, was a first class utility breed in its time It was one of the most popular breeds of the day It possessed great stamina was a good layer and a splendid table fowl, having white skin and legs

The breed is one that should have retained its popularity Unfortunately, the fancier ruined it by breeding for great size achieved by the further infusion of Cochin blood Its utility

North Holland Blue. This Dutch breed, of fairly recent creation, was brought to this country in the 1930s.

It appears that a number of breeds were used in its evolution, and, being still comparatively new, there is considerable difference between the quality of the available strains. A standard has, however, been adopted for the breed. In general appearance the birds resemble Barred Rocks, although the barring is not so regular.

This breed was first imported as a table bird, but has since been developed as a utility breed. It has white skin and legs, the flesh being abundant and of fine quality. It is built on substantial lines, with a broad, deep body and flat, horizontal back. Unfortunately, in some strains birds have more or less feathered legs, and when killed at certain stages of growth dark stubs detract from its value for the table. Light feathering on the shanks is accepted by the standard, a point that will handicap the breed for commercial purposes.

The North Holland White is a new variety not yet bred on a large scale. It may eventually supersede the Blue, since it more completely fulfils the requirements of the table-poultry trade. Most buyers prefer white or light-coloured birds.

The standard weights are: Cock 8½–10½ lb., cockerel 7½–9½ lb., hen 7–9 lb., pullet 6–8 lb.

The Marans. The Marans fowl is of medium size, having white flesh and clean legs, with cuckoo or barred plumage. It is a compact bird, fairly low on the leg, with medium length of body.

It is a good table fowl, but cannot be described as a great layer compared with the more popular breeds.

An outstanding feature of the breed is its egg colour—a deep rich brown that so many people find attractive. Unfortunately, in common with other breeds that lay very deep brown eggs, as egg production is improved, the shell colour becomes lighter, and as a consequence the more prolific individuals do not produce eggs of the deep colour for which this breed is well known.

The standard weights are: Cock 8 lb., cockerel 7 lb., hen 7 lb., pullet 6 lb.

Jersey Giant. This is the largest of the American breeds. It was developed from Asiatic breeds, and has attained immense size. The standard weight for the cock is 13 lb., the cockerel

possess in greater measure.

These breeds lay deep rich brown eggs, but not sufficient of them for the man who relies on his birds for a living. As already mentioned, regarding the Marans, as egg production is improved, so the colour of the eggs becomes paler. Some good layers produce eggs of a very washy hue.

The Indian Game. The Indian Game is used for crossing with the Light Sussex or other white-fleshed breed for the production of table birds of the very highest quality. It is of no value for commercial egg production.

The Indian (or Cornish) Game originated in Cornwall about the middle of last century. It was created by crossing the Malay and English Game.

It is characterized by its tight feathering, great width of shoulders, width between the legs and depth and width of body. Its breast is remarkably broad and deep and carries an exceptional amount of flesh.

Owing to the compactness of the body, the birds have a deceptive appearance, and few people without experience would be able closely to estimate their weight by observation. The standard weights are: Male 8 lb. (minimum), female 6 lb. (minimum).

Old English Game. This is a smaller breed than the Indian Game, but nevertheless is often used for crossing for table purposes, when it produces birds of very good quality. Weights lie in the range of about 5½ lb. for cocks down to about 4 lb. for pullets.

The Light Breeds (Commercial). The light breeds constitute a numerous class, but, as with the heavy breeds, few are of importance for commercial purposes. In this class there are

several breeds that are worthy of greater attention than they have so far received from utility breeders.

For some years the popularity of all light breeds declined because the heavy breeds were regarded as more economic, on account of the greater value of the hen when no longer profitable for egg production. While that is undeniable, it should be remembered that this advantage of the heavy breed is more than countered by the lower food consumption of the light breeds for each dozen eggs produced. On average a $4\frac{1}{2}$–5 lb. bird will eat about 10 per cent less food than a 6-lb. bird laying the same number of eggs.

Other factors being equal, the small bird therefore produces eggs more economically than the large bird because less food is required for body maintenance. The higher market value of the larger bird does not compensate for the higher feed consumption.

Today light breeds, light-heavy crosses and the rather smaller type of heavy breeds are in greater demand than formerly on account of their lower food consumption. They also require less house room.

It is a little unfortunate that the light breeds are so commonly described as non-broody. They are not so, but are certainly far less broody than the heavy breeds, though the broody instinct has not been eliminated. Taking a large commercial flock, it is probable that less than 5 per cent of the birds will become broody in the course of the year. Naturally the percentage is very variable. Some strains show much more broodiness than others.

All the light breeds are more active and nervous than the heavy breeds, but become quite docile under good management. They lay white eggs.

The White Leghorn. The White Leghorn, the most famous of the light breeds, shares with the White Wyandotte the distinction of having made poultry production a great industry. After the 1914–18 war these two breeds were to be found on most poultry-farms, and many kept no others. The White Leghorn was the commercial egg-farmer's fowl. It was the egg-machine.

The Leghorn is an Italian race of fowls first imported into America about 1835, and later from America into Britain, where it is believed they were crossed with other breeds,

Its popularity proved to be its downfall, for the [illegible] the breeders concentrated on raising its already high egg production. They disregarded other characters. Selection was based largely, and in most instances entirely, on the trap nest records, breeders competing with each other in advertising spectacular records, and the public aided and abetted them. The egg record was the sole arbiter of value. The higher it was, the more the public were prepared to pay for the stock.

It is no exaggeration to say that the White Leghorn had to withstand, or perhaps it would be more correct to say was expected to withstand, more abuse of the fundamental principles of breeding than any other breed in the history of the industry.

The inevitable consequence of years of thoroughly unsound breeding began to reveal itself in due course. The birds lost body size and stamina. The eggs became smaller and the shells thinner. Hatchability and rearability declined, and there was an ever increasing death rate among adults.

As the quality of the birds deteriorated, so they lost popularity. The majority of commercial farmers ultimately discarded them, and most breeders, finding little demand for the breed, replaced it with others becoming more fashionable. All breeders, however, did not follow this course. Some were determined to make every effort to repair the damage that had been done, and a few breeders have succeeded. There are now some first class strains in the country, but though the breed may become more popular, there seems little prospect of its ever regaining its former prominent position as a pure breed. It is commonly used for crossing and in the make up of the newer hybrids.

The white variety should be pure white in plumage. The comb is single, erect in the male, lopped in the female. Very large, coarse combs should be avoided in male birds.

D

Type in the Leghorn shows marked differences in the various strains, perhaps more marked than in many other breeds. This, of course, is undesirable, but it cannot be denied that some breeders have produced strains that do not correspond with the body conformation that should distinguish this breed.

Far too many strains lack size, the birds having narrow, shallow bodies, cut away in front and behind. The body should be of medium size; in general outline it should be wedge-shaped, wide across the shoulders and having plenty of depth, especially in the abdominal regions of the female.

The tail is full, well spread and carried rather high—at about 45 deg. from the back. The squirrel tail—*i.e.*, a tail leaning over the back towards the head—is a serious fault, and such birds should not be used for breeding.

Standard weights are: Cock 7½ lb., cockerel 6-6½ lb., hen 5½ lb., pullet 4½-5 lb.

The Black Leghorn. This variety is not so popular as it was a few years ago owing to the greater demand for birds of white or light plumage for intensive systems. Light-coloured birds are favoured because they reflect light. This improves the lighting in deep-litter and battery houses. Light or white birds are also preferred by table-poultry buyers.

However, the Black Leghorn is very hardy, a prolific layer and has given a good account of itself in laying trials. Egg-size is well up to standard, and generally speaking, body-size is satisfactory.

The breed is reputed to be very nervous. The birds can easily be made so, and when frightened will fly over 6-ft. netting with the greatest of ease. No well-managed flock, however, will be nervous. the poultry-man who knows his job will soon have a flock docile and friendly.

The Black Leghorn was much used for crossing with the Rhode Island Red. It is not widely kept to-day.

The Brown Leghorn. The Brown Leghorn is a very attractive variety It is not bred extensively, but the average quality of commercial strains is high.

It is a good layer of large eggs, average production being perhaps fifteen or twenty eggs lower than the White. It is very hardy.

Being a "gold" breed, the cockerels are frequently used

for crossing with "silvers" for sex linkage (see p 103) The Brown Leghorn × Light Sussex is the best known of these crosses

Type is, of course, similar to that of the White, and the standard weights for the variety are the same, although some strains of the Brown are smaller than they should be Head points are not usually quite so well developed as in the White

The general body colour is a rich brown with well defined black pencilling The plumage of the male is very colourful The hackle and saddle feathers are rich red, striped with black, and the breast and under parts are a glossy black, as also is the tail

The Exchequer Leghorn The Exchequer Leghorn is a sport from the White produced on the farm of Robert Miller, of Denny, Scotland, who bred from them He was of the opinion that, although breeding apparently pure Leghorns, there had been some years previously an infusion of Minorca blood, which was responsible for the mottled or chequered markings of some of the chicks Four or five of these chicks were found among as many thousands hatched in 1904, and since then the variety has been fixed

The cock has very dark neck and saddle hackles, each feather having white in the centre, the breast, wing bows and thighs are white mottled with black The hen has a white ground colour splashed with black

Birds of this variety are good layers, and high flock averages have been obtained from them

The Ancona This breed was undoubtedly evolved from common Italian stock, the Leghorn, which it so closely resembles in all characteristics except that of plumage markings

The late Sir Edward Brown said it would appear that fowls of this type were imported at least two decades before the Leghorn, specimens being exhibited in 1851 and subsequent years, and in 1861 at Birmingham The name is derived from that of the Italian port from which the birds were exported

The Ancona is so similar to the Leghorn that a separate description of type is unnecessary The ground colour of the

plumage is black, evenly ticked or mottled all over the body with white tips. Briefly, the breed is black, dappled with white splashes. The legs are yellow, mottled greenish-black.

For those seeking a hardy light breed that gives a good average egg production the Ancona may well be given more attention. It matures rapidly and, in common with other light breeds, has a nervous temperament, but, like others in its class, it soon settles down under good management.

In more recent years the breed has achieved some popularity in the commercial world for crossing. The Ancona crossed with the Rhode has proved its worth in the laying-house.

The Minorca. Years ago this breed was one of the most popular in the country. It earned its place on the farm and in the garden flock. It was a prolific layer of large white eggs. Unfortunately, its high utility qualities were destroyed by the fancier who bred for exaggerated show points. This, combined with the coming of the more prolific Leghorn, resulted in its decline. A few pens have been entered in the laying trials, but have met with little success.

There is no doubt that the Minorca has been used for out-crossing for the improvement of other breeds, especially Leghorns.

The Bresse. The Bresse is a French breed deriving its name from the Bresse country to the south of Burgundy, where it has been bred for many generations. In France it is famous as a table fowl. It may appear to be rather small for this purpose, but the flesh is fine in texture and very abundant. The birds fatten very readily, and the fineness of bone is a feature pleasing to both producer and consumer.

Owing to the absurd prejudice against slaty-blue shanks, the breed is not favoured in this country. This is to be regretted, for it is a most useful table fowl and a moderate to good layer.

In appearance the Bresse resembles the Leghorn, although somewhat shorter in the leg and having rather smaller comb and lobes. The shanks are dark blue-grey in colour.

There are four varieties—Black, White, Grey and Blue—the White being the most popular in Britain.

Weights range from about 5-6½ lb. for cocks to 4-4½ lb. for pullets.

The Legbar. The Legbar was evolved by crossing the Barred Rock with the Brown Leghorn. Since both the basic breeds are comparatively numerous and prolific, the Legbar is bred more extensively than other auto-sexing breeds, and has received much publicity.

What position this and other Cambridge breeds will ultimately occupy in the industry cannot yet be predicted. Much work still remains to be done before these breeds are brought up to the high commercial standard of the more popular breeds, and until this stage has been reached the poultry-farmer should not take them up on a large scale. If he is interested in these breeds, and perhaps the possibility of creating other auto-sexing varieties, he should first invest in one or two pens. Then he will be guided by experience. A standard for the Legbar was approved by the Poultry Club in 1945.

The birds are very active and alert, and, as may be expected in view of the Leghorn blood, they have a rather nervous temperament.

The body is wedge-shaped, wide at shoulders and tapering towards the tail. The breast should be broad and prominent, the abdomen full.

The general body colour of the cock is pale straw barred with gold-brown, that of the hen a dark or smoky grey-brown with indistinct barring. The legs and feet of the cock are orange or yellow; those of the hen orange, yellow or light willow.

The weights are: Cock 7–7½ lb., cockerel 6–6½ lb., hen 5–6 lb., pullets 4½–5 lb.

Importance of Strain. In any reference to breeds, the importance of strain or family must be emphasized. A breed is as good or as bad as a breeder makes it. For example, not all strains of Rhode Island Reds are prolific layers. Some are poor producers, some excessively broody and some lack stamina. This applies equally to other breeds.

Breeder A may have a strain of laying test winners. His stock may be capable of showing flock averages exceeding 220 eggs per bird under commercial conditions, provided the management is sound. But breeder B working with the same breed may have birds of such inferior quality that the possibility of

making a profit from them in the laying house is remote even under the best management

Crosses and Hybrids While the pure breeds are the foundation of the industry's stock, crosses are taking an ever-increasing part in commercial production of eggs and table poultry

Probably about 90 per cent of commercial flocks comprises first crosses and the newer hybrid strains, some of the latter being produced on an extremely large scale

First crosses and hybrids are the best all round proposition for the man who desires the most economic production of eggs and meat, and if he does not intend to breed from the birds, he will be well advised to invest in stock of this class

Most breeders now specialize in the production of first crosses or the more complex crosses—hybrids and strain crosses, some within closed lines, *i e*, lines in which new blood has not been introduced for many years

The breeding of pure stock is not, *per se*, an economic proposition The pedigree breeder derives the major part of his income not from the sale of pure-bred stock but from supplying the commercial egg and table-poultry producer with superior crosses of pure strains bred on pedigree lines

But it is as important for the buyer of crosses however designated to select the source of his stock with as great care as when he is buying pures, because the value of the cross depends on the quality of the parent birds

The following are among the most popular first crosses for egg production—White Leghorn × Rhode Island Red, White Leghorn × Light Sussex, Brown Leghorn × Light Sussex, Brown Leghorn × Rhode Island Red, Rhode Island Red × Light Sussex, Rhode Island Red × White Wyandotte, Buff Rock × Light Sussex, New Hampshire × Light Sussex

Hybrid strains are being used on an increasing scale by egg producers They are known by trade names and/or numbers of the breeders choice

Crosses for table work are discussed in Chapter Eighteen

Chapter Five

Poultry Breeding

The Principles of Inheritance. In recent years many new lines of approach to breeding problems have been formulated, all being designed to simplify the work of stock improvement and to speed up the process. While the sincerity of the propounders of these newer ideas is not in doubt, in some cases they have caused confusion among practical breeders, and they have in fact succeeded in adding to the complexity of the very problems they hoped to make easier for the man in the field to solve.

Nevertheless, scientific investigation has brought many new facts to light and shown that some old beliefs are untenable. The breeder now has a much firmer foundation on which to build his stock-improvement programme, but even with the most advanced knowledge and in the most favourable circumstances he cannot be assured of securing the results he desires except in limited degree. The scientist has not yet succeeded in presenting a system of breeding that can be relied upon to achieve the breeder's objective.

The fundamental principles of breeding have not changed with the passing of the years. No two birds are exactly alike in all respects, and it is because of this variability that the breeder is able to improve his stock by selection of the parent birds. He is, however, concerned with many characters, since he must select first for health and then for hatchability, rearability, egg production, egg size, body shape, colour of plumage and so forth. He must select for all the characters his customers may demand; he must try to produce a bird in which all the desirable characters are balanced so to speak.

When selecting breeding stock there is a tendency to have greater regard for one essential character than another equally essential character. That is the certain way to stock deterioration as every experienced breeder knows. He also knows that

it is extremely difficult to give due consideration to all traits of economic importance, and those who succeed in doing so are indeed first-class breeders.

If the breeder is to make headway it is essential for him to understand the basic principles of his work—that is to say, the principles of inheritance, the transmission of characters from parent to progeny.

The mating of male and female does not result in a simple mixing of blood—the progeny does not contain half the blood of the sire and half that of the dam.

All heritable factors are transmitted by the union of male and female reproductive cells from which the new individual is built up by the process of cell division. The initial cell divides into two, two into four, four into eight and so on, until there are many millions of cells in the adult bird all identical in heritable factors to the original fertilized cell. Blood and all body tissues are formed during the multiplication of these cells, a process known as mitosis.

In the act of mating, the reproductive cells of the male present in the semen are ejected into the cloaca of the female, traverse the oviduct and unite with the ovum (egg) shortly after it leaves the ovary. Although many spermatozoa are present in the semen, it is believed that only one fertilizes the ovum.

The reproductive cells are known as gametes. When male and female gametes unite they form the "zygote". This latter is the fertilized cell that, during incubation, develops into the chick.

Gametes contain minute, thread-like bodies known as chromosomes. These are of two types: sex chromosomes, which, as their name implies, are concerned with the sex of the progeny, and ordinary chromosomes or autosomes.

Chromosomes are responsible for the transmission of all the characters of the offspring, and since the number of characters far exceeds the number of chromosomes, each chromosome must contain a number of factors or "genes". In addition to the determination of the primary sexual difference, genes are responsible for economic factors, such as egg-yield, weight of egg, colour of shell, and external characteristics, including type of comb, colour of plumage, leg feathering and so on.

What an individual appears to be from visual inspection or

from its production record is termed its phenotype for the particular character Its genetical constitution for that character is referred to as its genotype It is not always possible to deduce with accuracy the genotype from the phenotypic appearance even with an external characteristic Thus a bird may have a phenotype for rose comb, but only a breeding test will decide whether it is pure or impure for the rose comb factor If, when mated with a single comb bird, all rose-comb progeny are produced, then this establishes its homozygocity for rose comb, but if both rose- and single-comb chicks appear, then the parent is heterozygous for the rose comb factor

The relation between phenotype and genotype becomes still more complicated with economic factors, for the phenotype, as indicated by records, may have been depressed by unfavourable environment, faulty nutrition and so on

For many years it was believed that there were seventeen pairs of ordinary chromosomes in the domestic fowl, but later work has shown that some doubt exists as to the precise number One cytologist has suggested that it may be as high as seventy odd For reasons which need not be discussed it has proved difficult to make accurate counts, but there is now general agreement that the number of pairs of chromosomes in the chicken exceeds seventeen An arbitrary figure of thirty eight is frequently accepted

In addition to the ordinary chromosomes, the male cell contains one *pair* of sex chromosomes It is still questionable whether the constitution of the female is one sex (X) chromosome per nucleus or one X chromosome and one Y chromosome, the latter not making any contribution to the determination of sex, but possibly containing genes for other characteristics

The male gamete always contains one sex chromosome, but the female produces sex cells of two types—namely, those containing one sex chromosome and those without a sex chromosome The female therefore determines the sex of the offspring (In mammals the reverse is the case)

Assuming that an equal number of the two types of cell are produced and that there are thirty-eight pairs of ordinary chromosomes—the number does not affect the principle—about

half the fertilized ova would contain thirty-eight pairs of ordinary chromosomes plus one pair of sex chromosomes, the other half would have thirty-eight pairs of ordinary chromosomes plus one sex chromosome only. The first type would develop into a male, the latter into a female.

The effect of a mating may be represented diagrammatically thus:—

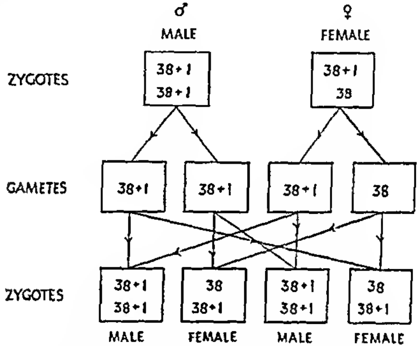


FIG. 11.—EFFECT OF UNION OF MALE AND FEMALE CELLS

When the ovum is fertilized, segregation and re-assortment and recombination of the various factors carried by the male and female gametes occur, and the various characters that the progeny will express depend on the manner in which these factors are arranged or "sort themselves out".

This is the basis of the Mendelian theory of inheritance. Mendel, an Austrian monk, investigated inheritance in peas and other plants. The result of his studies, published in 1866, was overlooked at the time, but about 1900 his work was rediscovered, and the results were confirmed by other investigators. Mendel demonstrated the principles of inheritance—namely, the segregation and re-assortment of the genes and the dominance of certain characters.

In 1902 Bateson showed that Mendel's laws applied to

inheritance in the animal world, and since that time many experiments involving the Mendelian theory have been carried out. Later work has shown that the inheritance of certain characters is far more complex than those with which Mendel was concerned, but the principles he propounded are the basis of the poultry-breeder's work.

An experiment by Bateson and Punnett demonstrates simple Mendelian inheritance in poultry. They mated Black with White Rose-Comb Bantams, the progeny all being black. The progeny of this the first filial (F1) generation did not consist of some black birds and some whites or a mixture of black and white in individual chicks. All were black, whether a black cock was used with white hens or vice versa.

In this mating the factor for black suppressed the factor for white. The former is called a dominant factor, the latter a recessive factor.

It is important for the poultry-breeder to realize that although the dominant factor suppresses the recessive factor, it does not eliminate it. The recessive factor is present in the progeny. It is merely hidden, and will express itself in the second or F2 generation (the black F1 being mated together) in a definite ratio of three blacks to one white. The white birds of the mating, if bred among themselves, produce only white, whereas when the black birds of this (F2) generation are bred together about one-third are black, the remainder produce blacks and whites in the ratio of 3 : 1.

Birds that breed true are known as homozygous, those that do not breed true as heterozygous. Thus the above mating produces homozygous white, heterozygous and homozygous blacks.

There are many characters in poultry that are dominant. For example, rose-comb is dominant to single, "silver" to "gold", barring to non-barring, white skin to yellow skin.

In the above example of Mendelism only two characters are involved. The inheritance of two pairs of characters is precisely similar in principle, although of course more complex, since the number of different combinations of the characters concerned is greater.

Suppose, for example, that a single-comb white bird is mated with a rose-comb coloured. Rose-comb is dominant to

single-comb, colour to white, therefore in the F1 generation all the birds will have rose combs and colour.

When the F1 birds are mated together, segregation and re-assortment of the characters conform to the Mendelian law. Four kinds of birds are produced · (1) rose-comb coloured, (2) single-comb coloured, (3) rose-comb white, or (4) single-comb white. They are produced in the proportion of 9 : 3 . 3 : 1.

The result of the mating may be set out in checker-board fashion (shown in Fig. 12).

	RC	Rc	rC	rc
RC	RC RC Coloured rose 1	Rc RC Coloured rose 2	rC RC Coloured rose 3	rc RC Coloured rose 4
Rc	RC Rc Coloured rose 5	Rc Rc White rose 6	rC Rc Coloured rose 7	rc Rc White rose 8
rC	RC rC Coloured rose 9	Rc rC Coloured rose 10	rC rC Coloured single 11	rc rC Coloured single 12
rc	RC rc Coloured rose 13	Rc rc White rose 14	rC rc Coloured single 15	rc rc White single 16

FIG 12 —MENDELIAN INHERITANCE

Showing the result of mating F1 birds produced by mating single-comb white with rose-comb coloured birds.

C represents eggs containing the factor for colour.
c represents eggs *not* containing the factor for colour
R represents eggs containing the factor for rose-comb
r represents eggs *not* containing the factor for rose comb

From Fig 12 it will be seen that the mating produces,—

1. Homozygous for rose-comb and colour (square 1)
2 Homozygous for rose-comb and Heterozygous for colour (squares 2 and 5)
4 Heterozygous for rose-comb and colour (squares 4, 7, 10 and 13).
2 Heterozygous for rose-comb, Homozygous for colour (squares 3 and 9)

1 Homozygous for rose-comb, Homozygous for white (square 6)
1 Homozygous for single-comb, Homozygous for colour (square 11)
1 Homozygous for single comb, Homozygous for white (square 16)
2 Heterozygous for rose-comb, Homozygous for white (squares 8 and 14)
2 Homozygous for single comb, Heterozygous for colour (squares 12 and 15)

There are thus 9 Rose comb coloured
3 Single-comb coloured
3 Rose comb white
1 Single comb white

A simple example of the Mendelian law will show its practical value to the poultry-breeder

Rose-comb is dominant to single, but every breeder of Wyandottes finds that a variable proportion of single-combs are produced, despite the fact that he has selected only rose-comb parents

The inheritance of rose- and single-comb is independent of the sex chromosomes—*i e*, it is an autosomal pair of characters Thus the female can be heterozygous for rose-comb as well as the male, and the method of isolating the heterozygous females would be to mate them to a single comb male, and in the case of suspected males, to mate them to single-comb females Only those birds of either sex giving uniformly rose-combed progeny would be homozygous for rose-comb

The matter is far more complicated when several factors are involved, for whereas with two characters one in nine of those birds showing both dominant characters in the F2 generation are homozygous and could easily be identified by mating with birds having the corresponding recessive characters, it would be necessary to test about 500 F2 birds to find all the birds that were homozygous for four characters

Punnett suggests that in these circumstances the breeder should not test more than one-eighth of the number of birds to find which are wanted, the breeder's procedure being guided in the mating of the F3 by what he had learned from the F2 generation Mating with a recessive will always show whether or not a bird is homozygous for a dominant character

Complementary Genes There are complementary genes

responsible for exceptions to the general rule of the 9 3 3 1 ratio that occurs in the progeny of individuals of two different characters

Bateson and Punnett found that a White Silkie and White Dorking are recessive whites, but when crossed produced coloured progeny The explanation is that two factors are necessary for the production of colour, and these two breeds are white because they have only one factor

When mated the two factors combine, and so produce colour Bateson and Punnett also showed that when the F2 birds were mated they produced coloured and white birds in the ratio of 9 7 respectively This is a modification of the 9 3 3 1 ratio

White Silkie and White Rose comb bantam when mated together produced white birds because both lack the genes responsible for the production of coloured plumage

Expressed in different terms, it can be said that two genes are essential for colour, one provides the colour, the other its "developer If one or both are lacking the bird will be white

All white birds however, are not recessive The best known example of a dominant white is the White Leghorn If this breed is crossed with a coloured breed it produces white birds, although some show a little colour The cross with the Rhode, for example, usually shows red on the shoulders of the males, while females may have a little red in the breast and neck feathers The inhibition of colour is not therefore complete, although for practical purposes it may be so regarded

When a cross with a White Leghorn is mated in the F2 generation, barred birds may appear in the progeny This is because the White Leghorn is usually but *not always genetically barred yet contains a factor inhibiting the production of colour*

Further evidence of this was obtained at the Northern Breeding Station Reaseheath, where closely inbred White Leghorns produced a number of barred progeny These Barred Leghorns bred true for the barring factor, moreover, they gave autosex linkage

Some White Leghorns are of gold or silver, black or red constitution only cross breeding will reveal their genetical make up

The best example of incomplete dominance is the blue

plumage of the Blue Andalusian. The blue colour is due to the partial suppression of the black pigment. When blues are mated together they produce black, blue and white offspring (the latter splashed with blue or black), in the proportion of 1 : 2 : 1. Blacks mated together produce blacks; splashed whites mated together produce splashed whites, the blues mated together produce the 1 : 2 : 1 ratio again.

By mating blue with black, equal numbers of blues and blacks will be produced, or blue with white splashed, which produce equal numbers of blues and white splashed. When, however, blacks are mated with splashed whites all blues are produced.

Blue is heterozygous, and the character cannot be fixed by selection.

Interacting and Additive Genes. In modern poultry literature reference is frequently made to interacting and additive genes. The former are so described when two genes, each producing a specific effect, acting together produce a different or third effect in changing or modifying the characters with which they are concerned.

A typical example of interacting genes is seen in mating pure rose-comb and pure pea-comb birds. The F1 generation have walnut combs, but in the F2 generation walnut, rose, pea and single combs appear in the proportion of 9 : 3 : 3 : 1. The single combs arise from interacting genes; they are not the result of impure breeding of the parent stock.

Additive genes all affect the expression of one character and are cumulative in their action.

It is not the purpose of this book to deal fully with heredity in poultry, but with this explanation of elementary principles the more practical problems may be considered.

It will be understood that the breeder is concerned with factors or characters in his work. Many of these are very complex and require further investigation in order to discover their behaviour in heredity. Egg production, for example, is not inherited in the same manner as rose- or single-comb; it is a complex factor or, as it is often called, a multi-factorial character depending on the interaction of a yet unknown but evidently large number of genes.

Modern methods of selection of pedigree stock are moving

away from the strictly phenotypic approach to the genotypic and from the individual to the family.

Mendelism gave the scientist a new outlook; it is still valid for many characters, but it must now be brought into partnership with later knowledge presented by the population geneticist.

Atavism, or the resemblance of the progeny not to their parents but to their grandparents, is readily explained. It is merely due to a combination of two or more factors possessed, but not expressed, by the parents. For instance, as we have seen, a bird may be black, but carry a factor for white,—*i.e.*, an inhibitor of colour. Mated with a black bird of similar constitution, white may be produced in the progeny because certain individuals may receive a double dose of white, so to speak, which inhibits the development of colour.

Reversion, or the sudden appearance of birds resembling their ancestors, is similarly explained, and must not be regarded as proof of the impurity of the parent stock.

Telegony refers to the alleged influence of a previous mating on subsequent progeny. It has been said that if a bird of one breed is mated to another of a different breed and later mated to one of the same breed, she will no longer breed true. That belief is completely erroneous. The sperm does not enter the blood of the hen. It fertilizes the ovum after it leaves the ovary. If no further mating takes place, fertility will decline rapidly after the first week, and in due course all the eggs will be infertile. If the hen is then mated with a male of her own breed, she will breed pure.

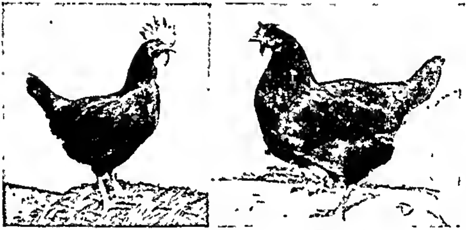
A bird that proves a good breeder—that is to say, impresses its good qualities on the progeny—is said to be *prepotent*. The explanation lies in the constitution of the germ cells. It has nothing to do with the appearance of the bird; on the contrary, some of the best birds, judged by their visible characters, prove indifferent breeders.

Apparent Change of Sex. From time to time instances of the apparent change of sex are reported. Usually the female is concerned in this phenomenon, the bird assuming the character and behaviour of a male. Such birds are called "cock-hens".

The condition is usually permanent, and in practice affected birds should be culled. It is not profitable to keep them with a view to their possible resumption of the female state.

If the birds are retained some individuals may start laying. At times a cock–hen with all the characteristics of the male, including crowing, will remain in this condition for a year or more; then it may moult into the normal plumage of the hen, assume the usual female characters and in due course start laying. The explanation is as follows:

The normal characteristics of the two sexes are influenced by the respective sex hormones. The sex hormone of the female normally inhibits the expression of maleness, but should its secretion cease owing to disease or other abnormal condition



Photos: Modern Poultry Keeping

FIG. 13.—APPARENT CHANGE OF SEX

This bird was a layer during her first season. Later she assumed the characters of the male (left) and crowed vigorously. She remained in this condition for her second year when she moulted, again assumed the characters of the female (right) and in due course began laying.

of the ovary, the bird assumes the characters of the male. The usual cause is an ovarian tumour, but any condition interfering with hormone secretion may be responsible.

Although instances of "cock-hens" having fertilized eggs have been reported, the author is not aware of a case of complete sex reversal in which a hen has become a sexually perfect cock, nor is he aware of a case in which a bird which began life as a male changed to a female.

Sex Linkage. A mode of inheritance whereby it is possible to distinguish the sex of day-old chicks was discovered at Cambridge by Punnett in 1921. It is known as sex linkage.

The phenomenon is perhaps most readily explained by

away from the strictly phenotypic approach to the genotypic and from the individual to the family

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A bird that proves a good breeder—that is to say, impresses its good qualities on the progeny—is said to be *prepotent* The explanation lies in the constitution of the germ cells It has nothing to do with the appearance of the bird, on the contrary, some of the best birds judged by their visible characters prove indifferent breeders

Apparent Change of Sex From time to time instances of the apparent change of sex are reported Usually the female is concerned in this phenomenon the bird assuming the character and behaviour of a male Such birds are called cock hens

The condition is usually permanent and in practice affected birds should be culled It is not profitable to keep them with a view to their possible resumption of the female state

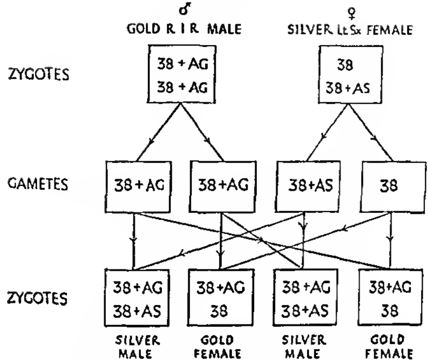


FIG 14—SEX LINKAGE, SHOWING TRANSMISSION OF GOLD AND SILVER FACTORS

A Sex Chromosome G Factor for Gold S Factor for Silver

FIG 15—RHODE ISLAND RED × LIGHT SUSSEX DAY-OLD CHICKS

The pullet chick is on the left

Photos *Modern Poultry Keeping*

FIG 16—RHODE ISLAND RED × WHITE WYANDOTTE DAY OLD CHICKS

Left pullet chick

reference to a popular sex-linked mating, the Rhode Island Red (male) × Light Sussex.

The Rhode is a "gold" variety, the Light Sussex a "silver", and when the Rhode male is mated with a silver hen it is possible to distinguish the sex of the baby chicks by the colour of the down. The male chicks are pale, silvery cream, resembling pure Light Sussex chicks, while the female chicks are a warm brown-red colour, resembling pure Rhode chicks.

If the reciprocal cross is made—that is to say, if the Light Sussex (male) is mated with the Rhode—all the chicks, irrespective of sex, will be silver, like day-old Light Sussex.

Silver is dominant to gold, but the factor for silver is carried by the sex chromosome of the female, and is transmitted to the male chicks only. The male transmits gold equally to both sexes, but the factor for silver which suppresses colour is received only by the male chicks.

In order to obtain sex linkage with a gold-silver mating it is essential to use a true breeding (homozygous) "gold" cock, although this does not apply to the hen, because any silver hen,[1] whether pure bred or not, will give linkage with a gold cock.

As already stated, the silver factor is carried by the sex chromosome of the female. The manner of its transmission is shown in Fig. 14.

There are various sex-linked crosses by the gold-silver factors, but many are of more scientific than practical interest, for the reason that comparatively few breeds have been bred up to a commercial standard of egg production.

The following are the most popular matings sex-linked by these characters. In every instance the male is given first:—

Rhode Island Red × Light Sussex. Subject to due care in the selection of the breeding stock, this is one of the most valuable crosses. It produces excellent layers and table birds. Moreover, it is very reliable for sex linkage, and few if any errors should be made in separating the sexes at hatching time.

For table birds Light Sussex hens may be crossed with other varieties of the same breed—*e.g.*, Red, Brown and Speckled Sussex cockerels. As none of the latter varieties is a prolific

[1] Other than dominant whites—*e.g.*, White Leghorn—and certain other white varieties in which the white behaves as a simple recessive to colour, *e.g.*, White Rose-Comb Bantam, White Silkie and some strains of White Dorking.

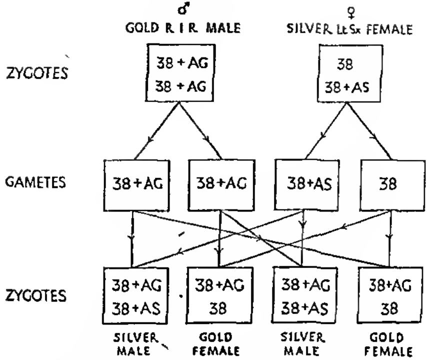


FIG. 14.—SEX LINKAGE, SHOWING TRANSMISSION OF GOLD AND SILVER FACTORS

A Sex Chromosome. G. Factor for Gold S. Factor for Silver.

FIG. 15.—RHODE ISLAND RED × LIGHT SUSSEX DAY-OLD CHICKS

The pullet chick is on the left

Photo *Modern Poultry Keeping*

FIG. 16.—RHODE ISLAND RED × WHITE WYANDOTTE DAY-OLD CHICKS

Left- pullet chick.

egg producer, they cannot be recommended for commercial purposes.

Indian (or Old English) Game × Light Sussex. Essentially a cross for table birds. It produces birds of the finest class, suitable for a market that demands the best and is prepared to pay for it. Sex distinction of day-old chicks is similar to that of Rhode × Light Sussex.

Brown Leghorn × Light Sussex. This mating is favoured by many commercial egg producers. The cockerels are a sound proposition for the table trade catering for the smaller class of chicken. The day-old pullets are a yellowish-brown with dark patch on the head, the cockerels are pale yellow or cream more or less splashed with black.

Brown Leghorn × White Wyandotte. A useful cross for egg production, while the cockerels make fair table birds at twelve to fourteen weeks old.

Unfortunately, White Wyandottes, or many individuals of the breed, are not true for the silver factor, possibly on account of an infusion of Leghorn blood by some breeders in order to improve egg production. On this account the Wyandotte is not altogether reliable for sex linkage. With some matings the error in sexing may be as high as 15 or 20 per cent.

Most of the pullet chicks are a warm buff-brown with gold stripes on the back. Chicks in which yellowish-cream predominates and those which are greyish or greyish-black are cockerels. In the writer's experience black chicks are usually, but by no means invariably, pullets. When in doubt, a good indication of sex may be obtained by examining the faces. Chicks having silver—*i.e.*, yellowish-cream—faces are, as a rule, cockerels The sex of chicks with whitish body-down is doubtful

Although impurity for the silver factor is common in this breed, it does not apply to all strains. Some males are homozygous for the character, and therefore show reliable sex distinction in the down of day-old chicks. Females are always heterozygous for a sex-linked factor.

Rhode Island Red × White Wyandotte. Sex distinction similar to the mating with the Brown Leghorn. At one time this was one of the most favoured crosses, but its popularity has declined, due first to the difficulty in sexing; secondly, on account of the

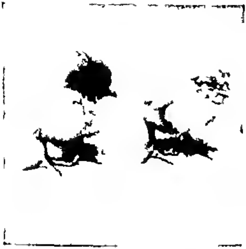


FIG 17 —BUFF ORPINGTON X LIGHT SUSSEX DAY OLD CHICKS

Left pullet chick

Photos Modern Poultry Keeping

FIG 18 — WHITE LEGHORN X RHODE ISLAND RED CHICKS

The dominance of the factor for white in the White Leghorn is clearly seen Both male and female chicks are silver Note the forward development of the wing feathers in the pullet chick on the left

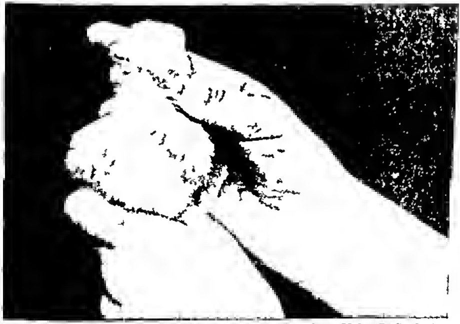


Photo Modern Poultry Keeping

FIG 19 —WHITE LEGHORN X RHODE ISLAND RED

The slow feathering of the cockerel is clearly seen at the day old stage

decline in the stamina of the majority of strains of Wyandottes. Pullet chicks are usually darker and more reddish in colour than the cross with the Brown Leghorn.

Sex Linkage by Feather Growth. *It is well known that* chicks of the light breeds feather more rapidly than those of the heavy breeds. Leghorn, Ancona and other light-breed chicks are fully feathered at a much younger age than Sussex, Rhode and other heavy-breed chicks.

Photo, Modern Poultry Keeping

FIG. 20.—WHITE LEGHORN × RHODE ISLAND RED

The well-developed flight feathers of the day-old pullet

The factor for rapid feathering is sex-linked. Serebrovsky (1922) described sex linkage by this character in a cross between Russian Orloffs and Barred Rocks. Three years later Warren showed that sex linkage was obtained with Leghorn males and Jersey Giants, the cockerel chicks being slow feathering, the pullet chicks rapid feathering.

It is clear, then, that slow feathering is transmitted by the dams to their sons, but not to their daughters. In order to

obtain sex linkage by this character it is necessary, of course, to use rapid-feathering males with slow-feathering females—*i e*, light-breed males with the heavy breeds

Further, it is essential to examine the chicks at hatching-time or very shortly after, because if this work is delayed some of the more rapid feathering males will be indistinguishable from the females Rate of feathering should be noted on the wings When removing the chicks from the incubator the wings should be fully extended, when it will be seen that some chicks have comparatively well-developed flight feathers, while in others they are still in the rudimentary stage The former are pullets

Experience is necessary to attain great accuracy Some breeders claim to sex 95–98 per cent of their chicks by this character

Many breeders have improved the rate of feathering in their strains of heavy breeds, so much so that the difference between light and heavy breeds in this respect is not very marked But fast feathering is of far greater economic importance than sex-distinction by feather growth

Sex Linkage by Shank Colour. Punnett (1925) crossed a Brown Leghorn male with Gold-Pencilled Hamburg In the F1 generation both sexes had light coloured shanks In the reciprocal cross the males had light shanks, the females dark coloured shanks The Brown Leghorn female carries a factor inhibiting the development of shank colour, and this factor is transmitted on a sex linked basis In Bresse × Light Sussex the blue shank of the former is sex-linked to the pullet

Although sex linkage is thus obtained, it is not of great commercial value, because the distinction is not usually sufficiently clear in day-old chicks to ensure accuracy As a rule pullets have dusky shanks When in doubt it is advisable to look under the feet, the cockerels usually showing clear pink while the pullets are of a dark hue Sexing errors, however, must be expected

In some crosses—for example, Black Langshan × White Orpington—all the chicks have black shanks at day old, but at about eight weeks of age the males have light shanks, while the females have black or blue black

Mann (1951) states that Silkie × Orpington (black × white

shank) gives an immediate and lasting effect which can be used in sexing chicks at day old. This mating is not of commercial value.

Shank colour is of assistance in sexing some of the crosses with the auto-sexing breeds, but breeds and strains vary enormously in this respect. Each breeder should study his own strain.

Taylor (1945) reported definite sex distinction at hatching in Legbar × Rhode Island Red and Brown Leghorn, the pullets having willow, the cockerels yellow, shanks.

Photo: Modern Poultry Keeping

FIG. 21.—SEX LINKAGE BY BARRING

The Black Leghorn or other black variety or the Rhode Island Red or other "gold" cock when mated with the Barred Rock or other barred breed will give reliable sex-linkage. The pullet chicks (*right*) are black except for the under parts, but the cockerels (*left*) have a white spot on the head. If gold cocks are used the progeny show more or less bronze.

Sex Linkage by Barred Plumage. Sex linkage by barred × non-barred characters ranks in importance with that obtained with the silver-gold characters.

The sex-linked inheritance of the factor for barring is the basis of the auto-sexing breeds. The result of mating a barred-breed male, such as a Barred Rock, with non-barred females (e.g., Black Leghorn or Rhode Island Red) shows that barring is a dominant factor. Males and females of the F1 generation are barred.

When, however, barred females are mated with non-barred males (except White Leghorns, White Rocks and Blues) the

male chicks of the F1 generation are barred, the female non-barred Barring in chicks is indicated by a white head-spot

A black or gold male × Barred Rock produces black chicks with yellow under-parts, but although the male is black like the female, it always shows the white head-spot This spot may be the merest speck or a large splash, but it is always apparent in the male, and so enables the chicks to be sexed with a high degree of accuracy.

Further, while the female chicks are black and lack the head-spot, the beak, shanks and toes are dark in colour, those of the males being yellowish

Male chicks develop into barred birds, females into black, with perhaps more or less red on the hackle and breast if a gold cock is used

The breeder is not restricted to the use of black or gold males He can use Light Sussex and most white varieties other than the White Leghorn Sex distinction is similar in every instance, namely, male chicks black on top of the body with a white head spot and yellow beak, shank and toes Female chicks black, without head spot and with dark beak and toes

Other barred females of commercial interest are the North Holland Blue and the Marans

Auto-sexing Breeds. Sex linkage involves the crossing of two distinct breeds or varieties

Thanks to the work of Punnett and Pease at Cambridge, there have been produced certain breeds that show sex distinction in the down of the day-old chick These are known as auto-sexing breeds

The first experiments were made with the Gold Campine and Barred Rock, and the breed produced was called the Cambar This breeds true, for it is in effect the Campine to which the barring factor has been added It was produced in 1929

Subsequently a number of "bar" or auto sexing breeds have been created, one of the most popular for commercial purposes being the Legbar, derived from the Brown Leghorn × Barred Rock All the auto-sexing breeds are produced by infusing the factor for barring in an unbarred breed

Barring has been shown to be a sex-linked character behaving in the same manner as the factor for silver It is carried by

the sex chromosome, therefore the males have a double dose, the females a single dose.

The creation of an auto-sexing breed can best be explained by describing the procedure adopted in producing the Legbar. This breed is made by mating a Brown Leghorn with a Barred Rock. This mating is sex-linked, and will produce black pullets, barred cockerels—*i.e.*, the cockerel chicks have the white head-spot.

The barred cockerels mated with Brown Leghorn hens produce black, brown, barred and unbarred chicks of both sexes.

From this somewhat mixed lot of chicks it is possible to select birds that are typical Brown Leghorn pullets, except that

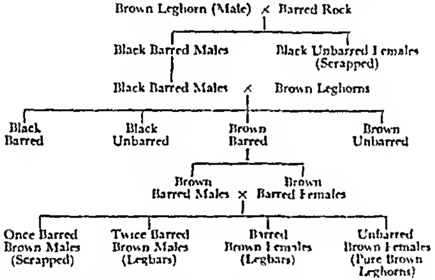


FIG 22.—DIAGRAM SHOWING MAKE-UP OF THE LEGBAR

they are barred. These pullets receive the single dose of barring on the brown, and are therefore pure Legbars.

The males, however, are impure for the barring factor because they have received only a single dose. When, therefore, they are mated with their barred sisters half the male progeny receive a double dose of barring, and as a consequence they are pure Legbar males, which may be used for breeding purposes.

Males having this double dose of barring may be distinguished from those with the single dose by their paler appearance and less distinct pattern. Single dose males are much darker with well-defined pattern. Good exhibition cockerels are usually impure for cuckoo barring because they generally carry the factor for black.

The make-up of the Legbar is shown in Fig. 22

It will be noted that the effect of the final mating is to "unbar" half the females, which therefore become pure Brown Leghorns.

The above procedure may be simplified by mating pure Legbar males with Brown Leghorns. The resultant pullets are pure Legbars, but the males are impure, and should on no account be used for breeding purposes, for they would cause the breeder great confusion.

The reason for the impurity of the male is explained by the fact that the barring factor is sex-linked on the usual cross-over

Photo Modern Poultry Keeping

FIG. 23.—DAY-OLD LEGBARS
Three daughters and a son

basis. The Legbar male is barred, and transmits this character to his sons and daughters, but the males can only receive a single dose, because they inherit the barring from their fathers only; from their mothers they receive the unbarred factor. The females are pure Legbars, because they have only one sex chromosome, and therefore one dose of barring.

It should be emphasized that this mating is not sex-linked by down colour. The males should be scrapped as soon as their sex can be distinguished by their combs and tails.

There is considerable variation in the appearance of both male and female day-old Legbar chicks, owing to the difference in the ground tint of the parents.

The pullets should have the same appearance as good-coloured Brown Leghorn chicks, with a clearly defined brown striping on a paler background. To ensure accuracy of sexing, care should be exercised, when making the breed, to use Brown Leghorns of good colour with distinct stripes, not blurred or too light, for the sexing of Legbars depends on the colour of the down.

The male Legbar chicks are much paler, the striping being more indistinct.

In order to safeguard himself against possible confusion in sexing, owing to the introduction of a new strain of Brown Leghorns giving a lighter ground colour and less distinct

Photo: Modern Poultry Keeping

FIG. 25.—SILVER CAMBAR CHICKS

The cockerel is in the foreground.

striping, the breeder is advised to buy eggs or chicks so that the colour and markings may be studied before the new strain is mixed with his own.

This is of special importance when breeding some of the newer varieties, in which sex distinction depends on the tint of the down.

In making auto-sexing breeds, the breeder is not, of course, confined to the Barred Rock. He could use such breeds as Cuckoo Leghorn, North Holland Blue and Scots Grey. Nor is he confined to the Brown Leghorn.

The origin of some of the new breeds is indicated by the names given to them.

Cambar—Campine
Legbar—Brown Leghorn
Dorbar—Silver Grey Dorking
Buffbar—Buff Orpington
Brockbar—Buff Rock
Brussbar—Brown Sussex
Welbar—Welsummer

The list of bar breeds is constantly being lengthened. It should, however, be pointed out that while it is a simple matter to add the factor for barring to give auto sexing, it is far more difficult to produce bar breeds of commercial worth. In many of the breeds already in existence much work remains to be done in improving egg production.

Sex Linkage with Auto-sexing Breeds. Auto-sexing breeds, unlike sex-linked crosses, may be used for sex linkage. A sex-linked pullet as usually produced cannot be used for this purpose, but with auto sexing breeds this does not apply, because sex linkage is obtained, provided gold and barred is kept in one parent, silver and unbarred in the other. In this way it is possible to make use of each pair of sex-linked characters every alternate year. Tests at Cambridge by Pease have shown that, provided the parent stock is selected with care in order to give clear distinction in the down of the day-old chick, the method may be relied upon.

He gives the following list of matings that will ensure sex linkage.

REPEATED SEX LINKED CROSSING — DIAGRAM OF MATINGS

Gold Brussbar Male (Gold and Barred)	×	Light Sussex Females (Silver and Unbarred)	
Black Jersey Giant Male (Silver and Unbarred)	×	Gold Barred Females	Silver Barred Males
Gold Cambar Male (Gold and Barred)	×	Silver Unbarred Females	Silver Barred Males
		Gold Barred Females	Silver Barred Males

Reference has already been made to sex linkage with Legbar males and Rhode females, the pullets having willow shanks and the cockerels yellow shanks. This also applies to Legbar × Brown Leghorn.

The reciprocal cross—*i.e.*, Brown Leghorn (male) × Legbar (female)—will give sex linkage by the barring factor, the cockerel chicks having brown down with a white head-spot, and the pullet chicks brown down without the head-spot.

Sexing Barred Breeds. The barring factor is carried in the sex chromosome, and consequently the male receives two doses, the female only one. Theoretically this should give clear sex distinction in the down of Barred Rock and other barred breed chicks. Comparatively recent work has shown

Photo: Modern Poultry Keeping

FIG. 25.—SEX LINKAGE WITH THE AUTO-SEXING BREEDS

The Legbar is a Barred Brown Leghorn and will therefore give sex linkage in a similar manner to the Barred Rock and other barred breeds. These chicks are Black Leghorn × Legbar. The cockerels have the white head-spot.

that chicks of these breeds can be sexed by this character, but considerable experience is required to attain a high degree of accuracy. Moreover, all strains of barred breeds do not behave alike. The breeder should study his strain.

Male chicks of these breeds are usually lighter in down than the female, and have a well-spread white head-spot, with silvery-white in face and throat. The shanks and toes are dusky yellow. Female chicks have a smaller head-spot, are usually black about the face with white spots, and have dark shanks with yellow at the tip of the toes.

Sexing Brown Leghorns. Investigations by MacArthur and MacIlraith (1946), Ontario Agricultural College, have

shown that day old Brown Leghorn chicks may be sexed by down colour and pattern By noting collectively the following characters, up to 100 per cent accuracy in sexing was secured

(1) The general down colour is darker in the pullet chicks than in the cockerels

(2) The head and back striping is dark and clear cut in pullets, and light and suffuse in cockerels

(3) Face stripes—darker down in pullets, pale, indistinct in cockerels

(4) Wing fronts—medium brown along edge and under wing fronts in pullets, light brown or creamy in cockerels

Sexing Day-old Rhode Island Red and New Hampshire Chicks The wings of "Red" cockerels carry an identification mark not present on the wings of the females The wings of the females are uniformly red in colour while the males carry a white or yellowish white spot on the top of the wing in the region of the wing web

Depending on strain, the accuracy of sex differentiation on this basis is up to 90 to 95 per cent with Rhode Island Reds With New Hampshire chicks their down is lighter in colour and accuracy is not so good—up to 80 to 90 per cent

The chicks may be sexed as soon as fluffed out Looking down on the back of the chick with its wings outspread, the white spot is seen in the middle of the wing, and its size varies considerably When small, it is situated towards the back of the wing web and follows the muscle outline of the forearm When it is very large, it extends over the upper surface of the web, and the wing is white Errors in sexing are most likely to occur in uneven and light coloured chicks and when the wing spot is so small as to be unnoticed

Experiments at the Oklahoma Agricultural Experimental Station have shown that it is possible to improve accuracy of sexing by selection of chicks for the breeding stock using female chicks of uniform down and no suspicion of wing spot and male chicks of uniform down with well pronounced wing spots

With continued practice it should be possible to maintain an accuracy of 90 per cent Breeding from selected and clearly marked chicks might improve results This method

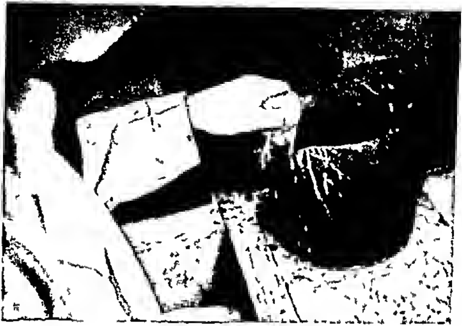


Photo Modern Poultry Keeping

FIG 26—VENT SEXING (1)

Hold chick in left hand as shown Firm pressure with thumb and fore finger will remove fæces from the intestines

Photo Modern Poultry Keeping

FIG 27—VENT SEXING (2)

Hold the chick in the fingers of the left hand with head between third and fourth fingers Place thumb of left hand on the left side of the vent, just touching the latter

has limited commercial possibilities at present but might be developed into a useful practice

Vent Sexing. A method of distinguishing the sex of day-old chicks by examination of the rudimentary copulatory organ was discovered by certain Japanese investigators and described by Masui and Hashimoto (1933) Earlier attempts were made

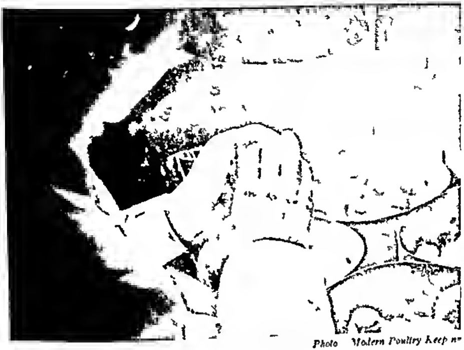


Photo Modern Poultry Keeper

FIG 28—VENT SEXING (3)

Place the fingers of the right hand on the opposite side of the vent the first finger and thumb being on the abdomen They should meet immediately above top of vent The thumb of the right hand should be against the abdomen with the nail about ¼ in below centre of vent The eminence is exposed by pressing the left thumb and forefinger inwards and slightly sideways the thumb of the right hand is pressed inwards and upwards under the centre of vent

to sex chicks by this method, but, whatever success was achieved, the practice was not applied on a commercial scale before the Japanese method became known

Provided the sexer has average sight and examines the chicks in a strong light, he should be able with a little practice to attain an accuracy of 80–85 per cent Although this is too low for commercial purposes, which demand 95 per cent accuracy, it is nevertheless of value to the poultry-man for sexing his own chicks on the farm

Greater accuracy can be attained only with long practice, and since sufficient chicks are not available on the average farm, anyone who contemplates becoming a professional sexer should contact a hatchery with the object of being trained.

Sexing calls for a strong light, a 300-watt daylight lamp being regarded as ideal. It should be fitted with a suitable shade to direct the light on the chick, while shading the sexer's eyes. The light should be below the level of the eyes.

A small table, three chick-boxes and a box or bucket into which the fæces are dropped, and an apron for the sexer, complete the equipment.

The genital eminence is found just inside the vent. It is always present in cockerel chicks and in many of the pullet chicks, and it is by close examination of the eminence that the sex can be distinguished

The eminence is situated in the folds of the cloaca, and in a cockerel chick it is commonly knob-like in appearance, while many of the pullet chicks have none. Some 80 per cent of the chicks are readily sexed because the cockerel eminences are quite distinct, but the remaining 20 per cent are more difficult to determine, and only practice will ensure great accuracy.

The chick is held in the left hand, as shown in the illustration, when pressure with finger and thumb will force the fæces from the vent. Care must be taken to avoid too great a pressure, or the yolk may be ruptured, with fatal results.

The chick is then held firmly with the left hand, with the side of the thumb touching the left side of the vent. The fingers of the right hand are placed on the other side of the chick in a similar position to those of the left, the vent being held between the first finger of the right hand and the thumb of the left. The thumb and first finger should be flat against the abdomen, and should meet just over the top of the vent. The point of the right thumb-nail should be just below the centre of the vent.

The cloaca is opened by pressing the left thumb and right forefinger inwards and slightly sideways, and at the same time pressing the right thumb gently forward and upwards into the abdomen. This action will expose the genital eminence.

Expert sexers work at an amazing speed, dealing with more

than 1,000 chicks per hour, but the beginner should not be disappointed if he sexes about 200 in that time

Chick Sexing by Instrument. The most recent development in chick-sexing is the use of a so called chick-sexing machine

This machine is based on the principle of the endoscope, an instrument which consists of a slender, rod like device with transparent tip The beam of an electric lamp is directed along the rod, and when inserted in the vent illuminates the

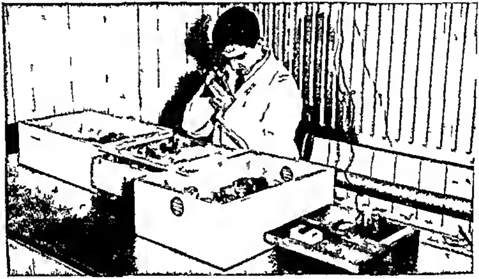


Photo Sexascope London

FIG 29—A SEXER USING A CHICK SEXING MACHINE

About 600 chicks per hour are sexed by this method

sex organs through the bowel The sexer examines the chick through an eye piece

These instruments may be used with electricity from the main with a transformer or from a battery

Experience is required to ensure speed and to avoid injury to the chick The instrument should be inserted in the correct position, and should not be moved from side to side when in the chick

After a short period of training, makers claim that the operator can sex some 600 chicks per hour with complete accuracy At the time of writing these instruments cost from about £25

Chapter Six

Stock Improvement

Early Investigations Egg production is an inherited character This is shown by the great improvement effected in the average egg production of our utility strains of poultry, all of which are descended from the wild fowl laying one or two clutches in the season

Birds with records of some 300 eggs in their first laying season are now comparatively common, and some breeders have so far improved their flocks that an average production of over 220 eggs per bird may be obtained

It must not be assumed that improvement is entirely due to breeding Environment plays an important part in controlling rate of growth and rate of egg production, it is very commonly the limiting factor affecting the expression of both these characters In other words, a flock may be genetically capable of rapid growth and high egg production but an unfavourable environment may prevent the expression of these qualities

Generally speaking, it is true to say that environment rather than breeding is responsible for the majority of complaints of poor growth and egg production, especially poor winter production There are, of course, exceptions

It is said that the expression of egg production depends to the extent of 70 per cent on environment, and only 30 per cent on heredity That is a fair measure of the importance of the former, but it in no way lessens the importance of the latter Both factors are essential, and to suggest that because egg production depends to the extent of about 30 per cent on heredity, breeding is of secondary importance is to ignore the fact that the most favourable environment cannot induce a bird to lay beyond her inherited capacity

It is a breeder's job to make a bird's inherited qualities of the greatest value to his customers, it is the customer's job to bring

out the best in the stock by providing the most favourable environment

The term environment includes all those factors affecting the welfare of the stock feeding, housing, protection from adverse weather conditions, temperature, length of day, disease and so on

The inheritance of egg production has attracted the attention of research workers for a great many years

Early in the 1900s breeding based on trap-nest records was undertaken at the Maine Agricultural Experimental Station (U S A) with the object of developing a strain of layers giving high egg production

Gowell (1902–3), working on first-year trap-nest records, failed to secure an improvement in production each succeeding year Although results were disappointing, his experiments became the basis of others that have led to a better understanding of what is undoubtedly a very complex problem

Pearl, continuing the breeding work at Maine Experimental Station, found that taking a mediocre flock it was a comparatively simple matter to improve production up to about 160 eggs per bird, but thereafter further selection based on the trap-nest record of the dam failed to raise average egg production

In 1909 he propounded the theory that if the factors for laying were represented by L1 and L2, and a bird possessed both of them, she would lay more than thirty eggs up to March 1st in her pullet year The absence of L1 or L2 resulted in a bird laying fewer than thirty winter eggs, while if both factors were missing she laid none

He further suggested that the factor L2 was sex-linked to the male—*i e*, a hen possessing it transmits the factor to her sons, but not to her daughters Accordingly, he believed that high fecundity was not inherited by the daughters from the dams This belief was widely held Indeed, for many years it was the breeders' tenet It remained for Punnett (1930) to disprove it in a series of tests involving Indian Game and Silkie, two breeds of low fecundity, and Light Sussex and White Wyandotte He could find no evidence to support Pearl's view that egg production was sex-linked

Goodale and his co-workers at the Massachusetts Agricultural Experimental Station continued investigations on similar lines

to those adopted by Pearl, and considered that the latter's theory of the inheritance of egg production was inadequate They concluded that egg production was not inherited on a sex linked basis and that several factors were involved The experiments were continued by Hays, who later confirmed the earlier work of Goodale

The Goodale-Hays Theory The Goodale-Hays theory was thus propounded, and has been generally accepted as the most comprehensive exposition of the inheritance of egg production Upon it, work of stock improvement is largely based to day

The theory is concerned with five principal factors These are —

(1) Rate of maturity (*i e*, the age when laying commences)

(2) Rate of production (*i e*, rate of laying during a given period)

(3) Persistency of production (*i e*, duration of the first laying season before the moult)

(4) Winter pause in production

(5) Broodiness

It should be emphasized, however, that the breeder must select for constitutional vigour as well as for production if he is not to produce a flock that may have inherited high fecundity but is unable to give expression to it because it lacks the essential vigour

In the selection of stock the breeder must never overlook the importance of constitutional vigour It must have first place in any breeding programme

After he has selected his birds for this character he should practise moderation regarding all others It might be assumed that this advice is easily followed Unfortunately, it is not It is extremely difficult to follow a middle course The breeder tends to place undue emphasis on one or two characters while neglecting others of equal or greater importance, and so he produces an unbalanced bird The result of this policy is always serious and may be disastrous

Selection for Vigour. *While the selection of breeding* stock demands far more skill and information than the selection

of birds intended for egg production, to a great extent similar characters are involved

In order to avoid needless repetition it is therefore proposed to discuss selection for egg production in this chapter, and to deal with the more intricate breeding problems later

Constitutional vigour is of primary importance, and every endeavour should be made to maintain the highest possible standard The success of the poultry-man's work depends on his having vigorous stock He must be prepared to harden his heart and kill or otherwise dispose of every bird that shows loss of vigour Should he fail to do so, it is certain that he will not get the best return from his flock, and he may get no return whatsoever Many farms have been given up solely because their owners have been unable or unwilling to dispose of birds that lacked vitality

Behaviour Close observation and judicious handling will enable the flock owner to recognize the weakling Much may be learned from the behaviour of birds, their action and their stance

Vigorous individuals show great activity and rarely appear to be tired They are the first to leave the perch in the morning and among the last to retire at night During the day they are constantly foraging, ranging far and wide in search of titbits They seem to be keenly interested in all that goes on about them Their movement is easy, that of the neck and legs being perfectly co ordinated The body is squarely placed on the legs, with no indication of heaviness in front or rear which gives an unbalanced appearance

The eye has been described as the mirror of vitality That is not an exaggeration, for it is well known among poultry-men that if any one character is considered, the eye most accurately reveals the state of health Vigorous birds have bold, prominent eyes that give a wide awake, alert appearance

Any bird having the slightest structural defect of the eye should be regarded with the gravest suspicion, and in no circumstances should it be used for breeding purposes, whatever its egg production record

The stance also indicates vigour When standing, birds should appear to be 'at attention' The wings and head should be held well up, the legs well spread, the birds standing square on their toes

Vigorous birds, too, are constantly chattering, and are always ready for their meals, unless of course they are over-fed.

Compare the above picture with that *of birds lacking in* vigour. They are sluggish. They spend many hours standing about the run, and seem to find life just as uninteresting as their

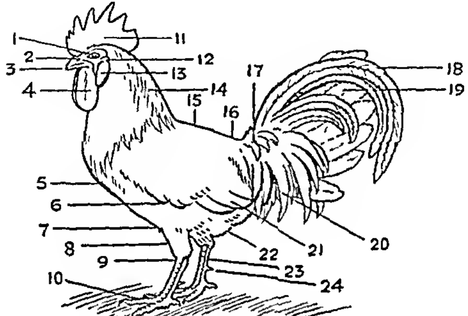


FIG 30—POINTS OF THE FOWL

1 Eye
2 Nostril
3 Beak
4 Wattles
5 Breast
6 Wing coverts
7 Breast bone or keel
8 Thigh
9 Hock
10 Toes
11 Comb
12 Ear
13 Ear lobe
14 Neck hackle
15 Back
16 Saddle
17 Tail coverts
18 Sickles
19 Tail
20 Saddle hackle
21. Secondaries which cover the primaries or flight feathers
22 Abdomen (fluff)
23 Shank
24 Spur.

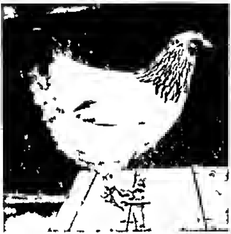
more virile companions find it of interest They do not hurry to leave the perch in the morning and are among the first to retire for the night. They frequently, too, return to the perch *for a rest during* the day, even during the short hours of daylight in the winter months.

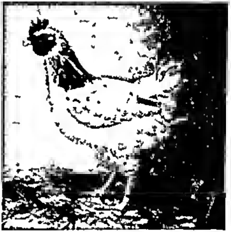
Walking and running appear to require great effort, and the movement lacks that ease and grace seen in vigorous individuals.

The body is often unbalanced on the leg, due to heaviness in front or rear, but more often to a "cut-away" chest and abdomen because of poor physical development. The eye is dull and sleepy, deep set, the eyebrows often overhanging.

The attitude adopted when standing is quite typical. The whole body relaxes, the wings and tail droop and the head is drawn into the shoulders.

Birds of this type are quiet; they rarely chatter. At feeding-time they will walk to the troughs and satisfy their appetites





Photos Modern Poultry Keeping

FIG. 31.—A LIGHT SUSSEX WITH A GOOD HACKLE AND A BAD BODY SHAPE

The body is unbalanced and appears heavy in front The bird walks clumsily

FIG. 31*a*.—CONFORMATION THAT GIVES A WELL-BALANCED BODY

Note how easily she stands She laid 185 eggs in nine months in the trap-nest house

with a few half-hearted pecks at the food, or they will stand aside until the vigorous birds have eaten their fill. Their feathers are loose and dull, in contrast to the tight, lustrous feathering of the vigorous birds.

Handling will usually confirm the evidence secured by observation.

Handling. Vigorous birds when handled show good muscular development, the whole body possessing firmness, strength and, relative to the strain, size.

The breast is well covered with firm flesh, the abdomen, if handled when the bird is in lay, is full and supple, with the pelvic bones well spread.

FIG. 32.—EXPRESSION TELLS. THE DULL EYE AND PALE FACE OF THE WASTER

Photos: Modern Poultry Keeping

FIG. 33.—THE BOLD EYE OF THE HEALTHY VIGOROUS BIRD

FIG. 34.—THE UNBALANCED BODY MARKS THIS BIRD AS A CULL

Birds of this type should be sent to the table.

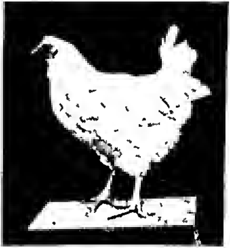
Photo. Modern Poultry Keeping

FIG. 35.—A RHODE ISLAND RED HEN OF SUPERB TYPE AND PROVED BREEDING QUALITY

Birds having little flesh on the breast, with tucked-up abdomens and breastbones like knife edges, are of low vitality, and are probably suffering from disease. On the other hand, individuals that handle like lead, with rounded breasts, full, hard abdomens and faces puffed up with fat are of the sluggish type. They are equally undesirable in the flock.

Fig. 36.—A TYPICAL CULL

The feathery face, poor development of comb and wattles and the loose feathering stamp this bird as a poor layer. The long claws show that she is not a worker.



Photos Modern Poultry Keeping

FIG. 37.—A BIRD WITHOUT A GOOD FEATURE

She has a long "parrot" beak, dull sunken eye, undeveloped comb and wattles, a crow head, loose feathering, long claws, a narrow, shallow body cut away in front and rear.

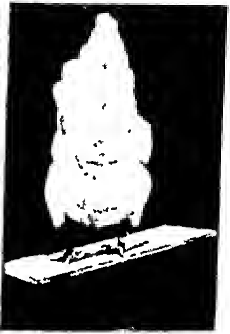
By noting the above characters it is a simple matter to identify the birds lacking in vigour, and if they are at once removed from the flock profits will be proportionately increased and the danger of disease (which usually originates with the weaklings) correspondingly reduced.

The birds that by their appearance, behaviour and handling qualities have every evidence of possessing an abundance of vigour should give a good account of themselves at least in the sense that mortality should not be high, but there can be no assurance on this point. In some flocks that have satisfied, by handling and observation tests, men of long experience and undoubted ability, heavy mortality has occurred in the course of the first laying year. But the breeder can be

assured that weaklings will never produce healthy profitable stock.

Further reference to this matter will be found in Chapter 7.

Selection for Egg Production. *The Head.* The comb and wattles are the secondary sexual organs. A close correlation exists between their development and condition and egg production.



Photos: Modern Poultry Keeping

FIG. 38.—POOR LAYERS USUALLY HAVE A WEALTH OF FEATHER BECAUSE FOOD IS USED TO NOURISH IT, WHEREAS—

FIG. 39.—IN GOOD LAYERS MUCH OF THE NUTRIMENT IS REQUIRED FOR EGG PRODUCTION, HENCE THE FEATHERING IS SHORT AND TIGHT

Prominent combs and wattles, when full red and waxy, indicate a well-developed, active ovary. In other words, they indicate the layer.

A prolific producer in full lay always possesses them, although of course when judging a bird for these points consideration must be given to the breed and strain, for size and type of comb are determined by the breeder.

Within the limits set for the breed or strain, however, this character is of importance in selection, and with few exceptions

it is true to say that a bird having these points well developed is not only in lay, but is a good potential producer.

Comb and wattle condition is not, however, constant. It

Photo: Modern Poultry Keeping

FIG. 30.—THE FULLY DEVELOPED COMB AND WATTLES OF A BIRD IN LAY

varies with the condition of the ovary. When a bird is in lay, the comb and wattles are red and enlarged. But when production ceases they shrivel, lose their fresh red colour and become pale and covered with greyish scales. Therefore, if a reliable estimate of production is to be obtained the head points should be studied at intervals throughout the year.

The need for this will be understood, since a bird may

have every appearance of being a good layer when she starts production, but may cease laying early in the season.

The thickness of the comb as judged when a bird is in lay is also of importance. Thick combs are associated with coarse-

FIG 41 —HEAD OF A NON-LAYER

When a bird is not laying the head points are much reduced in size and lose the fresh red colour

Photos Modern Poultry Keeping

FIG. 42 —HEAD OF A LAYER

Well-developed comb and wattles bold eye and tight feathering suggest that this pullet will complete her season with a good record of performance

Photo Modern Poultry Keeping

FIG 43 —HEAD OF A LAYER

The bold eye, "clean" face, short stout beak are characteristic of the good producer

ness, while very thin combs with little spread at the base are usually found in birds of the over-"refined" type, with narrow bodies and poor bone formation.

The Abdomen In the *Reliable Poultry Journal*, Walter Hogan in 1905 described his method of handling fowls to discover

whether or not they are in lay He was the pioneer, and all so called systems of handling are based on his work He

Photo Modern Poultry Keep ng

FIG 44—SPANNING THE BODY TO ASSESS WIDTH AND DEPTH

With the fingers on the breast bone the body is easily spanned This White Wyandotte fa ls to attain the standard required for breeding stock

Photo Modern Poultry Keep ng

FIG 45—THIS BIRD, ALSO A WHITE WYANDOTTE, HANDLED IN THE SAME WAY SHOWS GOOD DEPTH AND WIDTH OF BODY

pointed out the value of four measurements in assessing a bird s value for egg production

These measurements are the thickness of the pubic bones, the width of the pelvic arch—*i.e.*, the space between the pubic bones—the width between the end of the breastbone and the pubic bones (this he referred to as "capacity") and the shape of the skull.

Photo: Modern Poultry Keeping

FIG. 46.—MEASURING THE ABDOMEN

This bird is out of production. The pubic bones are drawn close together and it is possible to place only one finger between them.

Hogan's work was of great value because it gave the poultry-man a means of deciding which birds are laying and which are not. It demonstrated the value of handling in revealing physical condition as well as the state of the ovary. The factors to which he drew attention, however, are not sufficiently reliable to enable past or future egg production to be accurately estimated.

The measurements indicating whether or not a bird is in lay are the distance between the end of the breastbone and

pubic bones and the width between the latter These measurements are taken by placing the palm of the hand on the abdomen, the fingers being held together

When a bird is not laying, the pubic bones are very close together, and it may be possible to place only one finger

Photo Modern Poultry Keeping

FIG 47—MEASURING THE ABDOMEN

This bird is in full lay and shows a three finger span between the pubic bones

between them The end of the breastbone is also drawn closer to the pubic bones

When a bird is in lay she consumes much more food than when not in lay, as a result the intestines are greatly increased in size The oviduct is also much larger, to allow for the passage of eggs Consequently the bones referred to spread apart, and the abdomen becomes "full", soft and pliable

A bird in lay will have about a three finger space between the

pubic bones and a capacity of four or five fingers. It does not follow that the bird with the greater capacity is the better layer. Very frequently the reverse is true.

Moreover, even poor layers handled when in full production in the spring may show very good capacity. Further, in some

Photo: Modern Poultry Keeping

FIG. 48.—MEASURING THE ABDOMEN

This bird is not laying and shows only a two-finger " capacity ".

individuals the abdomen is greatly enlarged on account of the accumulation of fat, or yolk (due to *yolks falling into the body* cavity), fluid arising from dropsy or possibly to one or more tumours.

It is possible to determine the cause of an enlarged abdomen, because, unless it is the natural consequence of laying, it will be comparatively hard if the bird is over-fat, while a large tumour or the accumulation of yolk may be felt by the experi-

enced handler. Dropsy is readily diagnosed because the abdomen feels full of fluid.

Pliability of pubic- and breast-bones in birds is the result of *laying*. The phenomenon is precisely similar to that which occurs in pregnant animals. The bones soften, joints loosen and muscles extend.

Photo Modern Poultry Keeping

FIG. 49—MEASURING THE ABDOMEN

Fullness of the abdomen of a bird in laying condition Four fingers can be placed between the pubic bones and end of the breast bone

The width of bone is influenced by fecundity, because good layers mature rapidly, and when in production growth practically ceases, for the mineral salts used in bone formation are then required for egg production. Therefore the best layers have "finer" bone than the poor producers. Coarseness of bone is always associated with the heavy, lethargic type of bird, notoriously a poor layer.

It must be emphasized that fineness of bone is something that

can easily be carried to extremes. Selection for high egg production without regard to other factors has already done great harm to some utility strains. It has produced small-bodied birds lacking in stamina. Breeders now realize that good bone formation is essential in utility stock, but this does not imply coarseness.

An examination of the vent will also show whether a bird is

Photo. Modern Poultry Keeping

FIG. 50—THE VENT OF THE LAYER IS LARGE, MOIST AND CRESCENT-SHAPED

FIG. 51.—THE VENT OF THE NON-LAYER IS SMALL, DRY AND ROUNDED

laying or not. The vent of a bird in production is large, moist and crescent-shaped, and, in yellow-skinned breeds, white. The vent of a non-layer is small, dry and rounded, and more or less pigmented in yellow-skinned breeds.

Little need be said regarding the shape of the skull. Egg production cannot be determined by measuring the bird's head. The poultryman should be guided by the characters mentioned in describing the head points earlier in this chapter. The head should be judged as a whole, not by the shape of the skull.

Rate of Maturity. Rate of maturity, measured by the age of a pullet when laying starts, is correlated to production. The best layers almost invariably start laying at a comparatively

early age, while the poor producers are usually the late starters. This has been confirmed by experimental work and by the experience of practical men.

At what point a distinction should be drawn between birds considered to be late starters and those coming into production at a normal age is a matter of opinion. There is no accepted standard. Nevertheless, it may be assumed that no heavy-breed pullet that has not started to lay at seven months of age and no light-breed pullet at six months is likely to distinguish herself as a layer. As a rule it may be taken that light breeds hatched early in the season should attain 25 per cent production by 18–20 weeks of age, heavy breeds should reach this level of production at 20–22 weeks. Spring-hatched pullets usually take about two weeks longer to reach the 25 per cent output level, while some autumn-hatched birds may be laying at 16 weeks old and a few even earlier.

Moreover, among the more prolific laying strains there is little if any difference in age at first egg between heavy and light breeds; both classes now start laying at about the same age. This, of course, is a mere generalization. Some strains mature more rapidly than others in both heavy and light breeds.

Rate of maturity, although an inherited character, is also influenced by the length of day, so much so that the use of artificial light may mask genetic qualities in this respect.

Birds growing during the months of increasing hours of daylight mature more rapidly than those being reared when the days are getting shorter. Hence the rate of maturity of late hatched stock can be speeded up by artificial lighting in the autumn and winter months, while that of early hatched pullets can be retarded by simulating the light pattern of the autumn, *i.e.*, by rearing in windowless houses and allowing progressively shorter hours of artificial light.

The effect of light is discussed in Chapters Ten and Twelve.

Delayed maturity may be due to mismanagement, and the possibility of errors in feeding or other adverse factors being responsible should be considered.

Exceptional precocity is undesirable because it results in lack of body-size and stamina.

While early-hatched pullets mature *more rapidly than* their later-hatched sisters, they also grow more rapidly, and it

does not follow that early pullets will not attain the body-weight and egg-size of pullets of the same strain hatched later. If well managed and fed, early-hatched birds will ultimately attain the body-weight and egg-size they have inherited.

Egg-size. That egg-size is an inherited character is understood, although the exact mode of its inheritance is not.

Rate of maturity, feeding, climatic conditions and other environmental factors affect egg-size; nevertheless, however favourable are the conditions under which birds are kept, they will only lay eggs of the size determined by heredity.

Selection for this character is therefore essential, for in selecting for high production there is a tendency for both birds and eggs to lose size.

In practice the maintenance of egg-size and body-size are usually closely linked. Although all large birds do not lay large eggs or all small birds small eggs, the inheritance of the two factors is correlated, and no breeder can afford to ignore them.

It is therefore important to select for breeding birds that lay eggs of not less than 2 oz. Moreover, this weight should be reached within a reasonable time—*i.e.*, twelve-fourteen weeks after sexual maturity is attained.

Numerous methods of determining average egg-size of pullets have been suggested. Hutt found that weighing all eggs laid in one week is a reliable measure. He recommends that the work should be done in November or December, to give pullets the maximum possible time before judging them for this character. Hays found that egg-weight in February or March was closely correlated with the annual average.

Other investigators have suggested weighing the first ten eggs laid in the fifth month of laying; weighing on a given day each week throughout the year; weighing on the same day each week from January to July; weighing the first ten eggs laid in March.

Since the male bird influences egg-size, the breeder must avoid introducing cockerels of a small-egg strain. Should he do so a considerable proportion of the progeny may lay small eggs. The egg-weight of the sire's dam should be ascertained.

Olsen and Knox (1940) showed the possibility of increasing average egg-weight by progeny testing. They succeeded in

increasing the average egg-weight for each of the five years the experiment was carried out. They also succeeded in reducing the age at which pullets laid the standard egg (2 oz.). It is interesting to note that they concluded that sire and dam were about equal in their influence on egg-weight.

Rate of Production. Rate of production, or, as it is sometimes called, intensity of production, is obviously important because a bird that lays five or six eggs a week is clearly a better layer than one producing two or three eggs. The best means of assessing rate of production in commercial flocks is to divide the number of eggs laid during a short period by the number of days.

Persistency of Production. Usually the longer production continues prior to the annual moult the greater the total production for the pullet year. Birds that cease laying in the early summer months are poor producers as a rule, while those laying well into the autumn before dropping their feathers are the best layers. The date of laying the last egg in the production year is a reliable indication of persistency, but, as pointed out below, some of the most prolific producers continue to lay throughout the moult.

Winter Pause. Few pullets remain in continuous production from the start of laying until the annual moult. The majority take rests of longer or shorter duration, and for a variety of reasons. Any pause in production necessarily reduces the number of eggs a bird may lay in a given period, but a winter pause has the greater effect on profits.

There does not appear to be evidence to show that the winter pause, as such, is inherited. Lerner and Taylor (1947) failed to increase significantly the incidence of the winter pause in birds selected for it; on the contrary, the amount of pausing was reduced in birds selected for high production.

The less prolific layers are naturally more likely to pause in winter and at other seasons than high producers. In practice much of the winter pausing has its origin in errors in management and outbreaks of disease.

Lerner and Taylor (1947) state that the winter pause may be arbitrarily defined as a period of non-production of seven or more consecutive days, which start before March 1st, of the first laying year.

Broodiness. The incidence of broodiness in different strains and in individuals of the same strain varies enormously, which shows that the trait is inherited. It is said to be due to two complementary genes, both of which must be present in broody hens.

Evidence of sex linkage has been produced by several investigators. Roberts and Card (1933) crossed Leghorns with Cornish Game and found that 88 per cent of the pullets from the Cornish sire went broody, but only 37 per cent from the Leghorn sire. Kaufman (1948) in reciprocal crosses between Polish Greenlegs and Leghorns found that no pullets from the Leghorn sire went broody, but 78·5 per cent of the pullets from the Greenleg sire did so.

Broodiness is of economic importance, for it is accompanied by cessation of egg production.

This being so, efforts have been made to reduce its incidence as far as possible, and in the light, or so-called non-sitting, breeds a considerable measure of success has been achieved. Even in the light breeds, however, it has not been eliminated.

At one time much was heard of non-broody strains. This description is misleading, for the fact that a bird is non-broody in her pullet year is no guarantee that she will not be broody in her second, nor is it a guarantee that she will transmit non-broodiness to her daughters.

Continuous selection for high egg production has naturally reduced the incidence of broodiness in all utility strains, including those of the heavy or sitting breeds.

It is impossible to have excessive broodiness and high production, but a bird that is broody occasionally during the year is not necessarily an inferior producer.

After broodiness a bird may lay at a faster rate than one showing no broodiness, and may in fact complete the year with a better egg record than a bird that was not broody. It is therefore not wise to dispose of individuals merely because they have one or two spells of broodiness. Nevertheless, in general it can be said that broodiness lowers annual average egg production. This has been demonstrated by Hays, Jull and other investigators.

Moreover, in modern commercial practice broody hens are a nuisance, and labour is required to deal with them. Hence

breeders should discard all birds that go broody if non-broody birds of otherwise comparable quality are available.

The Moult. The season and duration of moulting are closely related to egg production. Of all the various characters considered when selecting birds for production, the moult has the greatest significance, although no poultry-man would ignore other characters already discussed.

Egg production does not cease because a bird begins to moult. It would be more correct to say that the moult begins with the cessation of production. This may be explained by the fact that when a bird is laying, the bulk of the food is

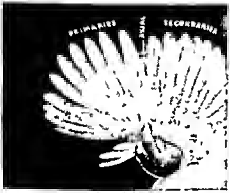


FIG. 52.—THE WING OF A BIRD IN FULL PLUMAGE

Showing the ten primary or flight feathers, the axial in the centre and some of the secondary feathers on the right

Photos Modern Poultry Keeping

FIG. 53.—THE WING OF A BIRD MOULTING AT A MODERATE RATE

Two feathers are about half-grown before those next to them are dropped

required to maintain body condition and egg production. There is little or no surplus to nourish the feather.

When egg production ceases or slows down nourishment is available for feather growth, and the bird moults. This explains why the late moulter is usually a good layer.

That is not the whole of the story. A good layer not only moults late, or comparatively late, in the season, but when production ceases the moult is usually rapid. This is because the factors that ensure high production—constitutional vigour, ability to assimilate food efficiently, and sound management—also ensure rapid moulting.

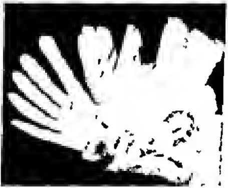
Some of the best layers, however, do not cease laying when

moulting starts. They may continue to lay, although at a slower rate, for some time after the onset of the moult. Exceptional birds may lay more or less throughout the moult.

A bird that is capable of doing two jobs at the same time must be regarded as among the best layers, but not necessarily a better layer than one that stops laying when moulting begins. The continuance of production during the moult retards the rate of moulting. The reason will be understood, and allowance made for this when judging for production.

FIG. 54.—THE WING OF A RAPID MOULTER

The bird is replacing a number of primary feathers simultaneously.



Photos: Modern Poultry Keeping

FIG. 55.—THE WING OF A SLOW MOULTER

New feathers are almost completely grown before others are dropped.

Poor producers usually moult early in the season and moult slowly. They rarely show bare patches, because they moult a few feathers at a time, new feathers being fully grown before many of the old are dropped.

In very poor layers stubs of new feathers may be found on the birds at almost any time of the year. They may lay a few eggs, stop laying, drop a few feathers, then start laying again. This alternate moulting and laying at short intervals may continue for many months.

Good producers present a very different picture. They retain their feathers throughout the long period of production; hence towards the end of the season the plumage shows signs of wear and tear. When they moult they do so rapidly, and on this account they often show bare patches.

Rate of moulting can be determined by examining the flight-

feathers If the wing of a bird in full plumage is fully extended, counting from the extreme tip farthest from the body and ignoring the small finger-feathers, there is a row of ten large primary or flight-feathers, then a small feather (the axial), followed by fourteen secondary feathers

The primary feathers usually drop in regular order, beginning with No 1 (next to the axial), followed by No 2 and so on, until No 10, the feather next to the finger-feathers, is dropped Occasionally No 2 may drop before No 1 This is not significant

Birds that moult rapidly will replace two or more flight-feathers simultaneously, or they will drop in rapid succession, so that the difference in the length of the new feathers growing in will not be great Birds moulting slowly will show considerable difference in the length of the new primaries

The growth of a primary feather is usually completed in six or seven weeks, therefore the presence of a fully grown feather would indicate that the wing-moult commenced six or seven weeks before the examination was made It would not indicate that the bird had been out of production for this time Irregularity in the order of moulting occurs when pullets have a partial moult during the winter The annual moult then begins where the partial moult stopped, the feathers replaced during the partial moult being the last to fall during the annual moult

Generally speaking, pullets moult earlier and more rapidly than hens, but whatever the age of the bird the poor producer moults early, frequently dropping her feathers in June

All birds completing the moult by the end of August should be regarded as early moulters, those moulting in October and November as late moulters

There are many factors affecting the time of the year at which moulting starts, and also its duration A spell of hot weather may cause early moulting, as also will under-feeding, undue disturbances such as moving a flock when in lay, or fright by dogs or foxes Poor physical condition of the birds due to insect pests, colds, internal parasites and so on may also be responsible for an early and protracted moult

In order to ensure that the moult will be completed as speedily as possible it is essential to keep the birds in good

physical condition. Any factor having an adverse effect on health will slow down the rate of moulting.

The practical man measures the duration of the moult by the length of time a bird is out of production. Individuals differ markedly in this respect, some taking four months or more to complete the process. The average time may be taken as eight to ten weeks or thereabouts.

Pigmentation. In yellow-skinned breeds pigmentation is of some value in the selection of laying stock, but it is by no means so reliable as other characters to which reference has been made.

The yellowness noted in the beak, shanks and fatty tissues throughout the body, and in the egg-yolk, is derived from the plant pigment xanthophylls, present in green plants and certain grains, notably yellow maize.

C. A. Schenck (1904) pointed out that close relationship exists between the pigment found in green plants and egg-yolk, and since that time a great many investigators have carried out experimental work on pigmentation in poultry.

Palmer (University of Missouri) fed birds on three different rations, one containing a large amount of xanthophyll, one with a low xanthophyll but high carotene content and one containing no appreciable amount of either pigment.

He showed that a few days' feeding of a pigment-free ration was sufficient to reduce the yolk-colour to its lowest level obtainable on that ration. A ration with a high xanthophyll content began to increase yolk-colour as early as the second day, while the result of feeding a ration having a high carotene content was similar to that obtained with a pigment-free ration.

Carrots, a rich source of carotene, failed to have an appreciable effect on yolk-colour.

Further, palm oil, also a very rich source of carotene, was ineffective for this purpose.

Subsequent experimental work has shown that only xanthophyll pigment is responsible for yolk-colour and pigmentation in poultry where normal rations are fed.

Gage and Gage found that a fat-soluble dye known as Sudan 3 was transferred to the yolk and the body of the young chick. Morgan and Woodroff (1927) showed that the pigment in pimento pepper or paprica (*Capsicum annum*) behaves in a

similar manner Fed at a level of $\frac{1}{3}$ to 1 gramme per bird daily, it imparted a desirable colour to the yolks When fed at the rate of 5 grammes per day the yolks became reddish-brown. Taylor (1945) confirmed these results He found that when fed at levels varying from $\frac{1}{3}$ to 5 grammes per bird per day yolk-colour varied from orange to brick-red He also demonstrated that pimento (*Pimenta officinalis*), commonly known as allspice, is ineffective in improving the colour of the yolk

Fresh greenstuffs, alfalfa and grass meal, and/or yellow maize will supply sufficient pigment in the average ration to ensure satisfactory yolk-colour

It is well known that in the course of laying, yellow-skinned breeds gradually lose the pigment, which disappears first from the vent, followed by the eye-ring, ear-lobe, beak (base to tip), feet, shanks and hocks

The loss of pigment was at one time commonly believed to be due to its transference from the body-tissues to the yolk, but there is now evidence to show that it arises from excretion through the skin and the natural physiological changes that occur in it

That loss of colour—" bleaching ", as it is usually termed—is not due to withdrawal of pigment for yolk-formation, is shown by the fact that it is a simple matter to " bleach " birds by feeding a pigment-free ration This is commonly practised by table-poultry producers who wish to supply the market with white-fleshed birds

Pigmentation is not a reliable indication of the number of eggs produced, for the following reasons —

(1) The amount of pigment present in individual birds varies enormously
(2) Individuals differ in the rate of pigment loss
(3) The amount of pigment in the food is responsible for the degree of pigment present in the birds

Pigment may disappear from the vent before eggs are laid, because about two weeks are required to form the yolk, and during that time pigment is used in yolk-formation, none being transferred to the body-tissues On the contrary, some birds may lay ten to twenty eggs before the vent is bleached.

According to Lewis, the average production required to

bleach the beak is between thirty and forty eggs, or seven or eight weeks' steady production

From observations by Palmer and Marble the average number of eggs required to bleach the bottom of the feet is 67 8, the front of shanks 95 9 the back of shanks 159, and the hock joints 180 7

For reasons stated, production cannot be estimated in this arbitrary manner Some birds lose the pigment very rapidly while others, even though prolific layers, will not be entirely bleached at the end of a long period of production

Pigmentation is a useful guide when culling a flock, because it is evident that when the majority of birds are more or less bleached, those heavily pigmented are either poor layers or have been out of production for some time When laying ceases pigment returns in the same order as it disappears

Some poultry men are of the opinion that pigmentation and vigour are correlated, that birds lacking in pigment must therefore lack vigour There is no evidence to support this view, which completely ignores the fact that white skinned breeds carry no pigment, but no one has suggested that they lack vigour

However, since pigmentation is associated with body fat, its absence may be due to poor physical condition of the bird That could be ascertained by handling Lack of pigment is not itself an indication of low vitality

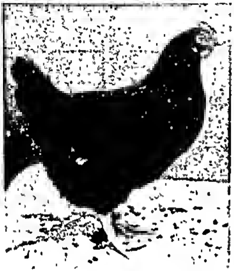
Selection of Breeding-stock The selection of breeding stock is based on the same principles as the selection of layers so far as such factors as egg production, egg size, body size stamina and so on are concerned

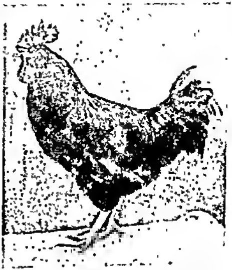
A good breeder must be a good layer, but it by no means follows that a good layer is necessarily a good breeder *Indeed the opposite is frequently true*

The success of the breeding programme depends primarily on the vigour of the parent birds That is the first lesson every breeder must learn If he allows egg production records breed characteristics or other factors to induce him to breed from birds that lack stamina, then he is adopting a policy that can only lead to progressive deterioration of the stock which will express itself in lower fertility, hatchability and rearability and an ever ascending death rate among adult birds

Vigour is indicated by physical development, by activity, keen alert appearance and ability to resist disease, to produce virile stock and to live a reasonably long life.

It may be stated that, with the exception of a few minor ailments, no bird that has suffered from disease should be placed in the breeding-pen. Indeed, no such bird should be available for selection, because treatment of individuals is not





Photos: Modern Poultry Keeping

FIG. 56.—THE KEEN, ALERT APPEARANCE AND DEPTH AND WIDTH OF BODY OF THIS RHODE ISLAND RED PULLET ARE AMONG THE FEATURES THAT INDICATE HER PRODUCTIVE ABILITY

FIG. 57.—A SUITABLE SPECIMEN WITH WHICH TO MATE HER. A PEDIGREE RHODE ISLAND RED COCKEREL OF THE TYPE REQUIRED FOR BREEDING UTILITY STOCK

justified. It is wiser to kill or market them as soon as they show symptoms of ill-health. Even if they recover or appear to recover, they are unlikely to be profitable.

The most conclusive evidence of vigour is the ability of the bird to maintain a satisfactory level of egg production for two or three years, to maintain or increase body-weight during that time and to produce a large number of healthy progeny.

Body-weight. Strains differ widely in average weight. While the loss of a few ounces during the laying season may not be sufficiently serious to warrant rejection, it is desirable that breeding-stock should increase in weight.

Loss of weight indicates that a bird is unable to assimilate sufficient food to support egg production and physical condition at the same time. It reveals a weakness, and hence such birds should not be used for breeding.

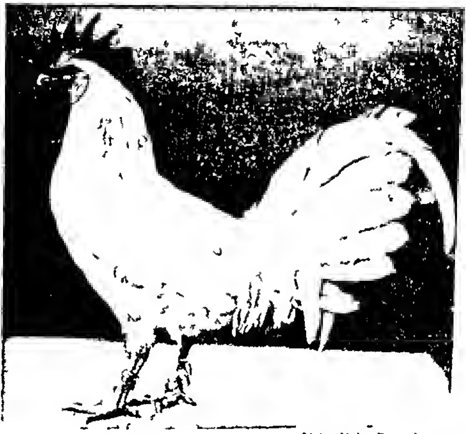


Photo: Modern Poultry Keeping

FIG. 58.—A UTILITY WHITE LEGHORN COCKEREL, INDIVIDUALLY BRED AND OF SPLENDID TYPE FOR THE BREEDING PEN.

The following should be regarded as the *minimum* weight of breeding stock of the popular utility breeds:

Leghorn	Pullets 4 lb.	Cockerels 5½ lb.
Rhode Island Red, Wyandotte	5 ,,	7 ,,
Sussex	[illegible]	[illegible]

Body weight in laying strains is of economic importance for the reason that the larger the bird, the more food required for maintenance. Given the same level of egg production, a small bird will produce eggs more economically than a large one.

Some breeders are producing the smaller type of bird for commercial egg production. There can be no valid objection to this, provided always that there is no loss of viability or egg size.

Small birds are not necessarily less viable than large birds;

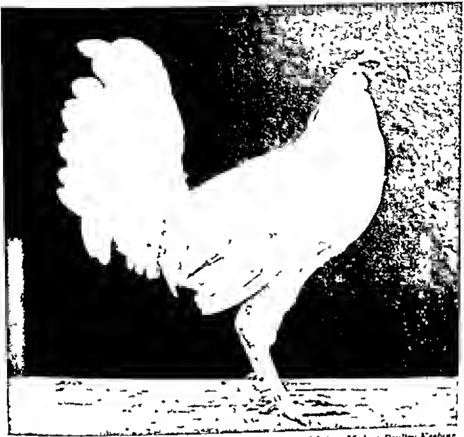


Photo Modern Poultry Keeping

FIG. 59.—THE TYPE OF WHITE LEGHORN COCKEREL FIT ONLY FOR THE TABLE

This bird has all the characters of the cull Even the camera terrifies him

body size and viability are not correlated, but body size and egg size are related.

Further reference to body size and feed consumption will be found on p. 428.

Since the ultimate destination of the majority of birds is the table, selection for body conformation is clearly important, even in strains bred primarily for egg production.

F

The housewife will always prefer a bird with a well-rounded breast, to one having a prominent keel.

Rate of Feathering. Fast rate of feathering has become a matter of importance, and the more progressive breeders are paying great attention to it.

Slow feathering is undesirable; it encourages feather-plucking and cannibalism, and it is a big handicap in table-poultry production.

Rate of feathering can be determined by noting the growth of the wing-feathers of the day-old chick or the length of the tail feathers at 10–14 days.

Egg-production Records. While the breeder cannot afford to ignore the egg-production records of his stock birds, too much attention must not be paid to them. Let it be repeated that birds must first be selected for vigour. Vigour is paramount.

But, other factors being equal, hens with high egg-production records in their pullet year are usually the best breeders. The old idea that they produce few and/or weakly offspring has been proved completely false. No breeder who wishes to secure high average egg production should hesitate to mate birds with high records. Certainly he will not breed a prolific strain if he discards them.

High egg production is not opposed to high breeding value, unless it is associated with inability to maintain weight and other undesirable characters.

Hens with pullet year records exceeding 200 eggs are to be preferred for the breeding-pen, but a bird laying about 180 eggs should not necessarily be rejected, provided other characters are satisfactory.

The sire should be the descendant of a family of high producers or, if individually bred, his dam's and his sire's dam's record should be 240 eggs or more.

Hays (1952) investigated the breeding efficiency of 300-egg hens compared with their full sisters that laid fewer than 300 eggs in the pullet year.

He found that in egg production the pullet progeny of the former were definitely superior. During the third and fourth laying years the daughters of 300-egg hens and the daughters of their full sisters that laid fewer than 300 eggs averaged to lay about the same number of eggs, but, Hays pointed out, " this

last result may be due to the fact that all available 300 egg hens were used as breeders in their third and fourth laying years while their full sisters were only retained if they had demonstrated superior breeding ability'

While there is some evidence that very high egg production may adversely affect breeding ability after the first year, Hays found that as a rule 300 egg hens were likely to be superior to their full sisters as breeders in raising the average egg production of the flock

Short period Trap nesting Dudley (National Poultry Institute, 1931) investigated the possibility of estimating annual egg production by trap nesting for short periods

The periods he examined were —

1 Four consecutive days in the middle of each lunar month

2 One day each week

With the first method he found that in 58 per cent of the cases the annual production was within twelve eggs of the estimated production, in 28 per cent within thirteen to twenty four eggs, in 9 per cent within twenty five to thirty six eggs, and in 5 per cent within thirty seven eggs and over The respective figures for trapping one day per week were 56, 30, 11 and 3 per cent

According to Lippincott and Card (1939), there is a close correlation between the number of eggs laid in the first three days of each twelve months and the total production for the year

The Poultry Stock Improvement Plan Regulations 1959–60 provide for trapping on a five, six or seven day basis If five day or six day week trapping is practised the full egg production record is obtained by multiplying the number of eggs recorded on a five day or six day week trapping routine by $\frac{7}{5}$ or $\frac{7}{6}$ respectively, fractions in the final figure being ignored

It has been shown (Hutt, 1959) that trapping for four days a week will provide records adequate for the differentiation of both sires and dams families

Hutt suggests that in order to detect good individuals and good families the breeder who makes up his breeding pen in January can get a fair appraisal of the stock by trapping the

pullets hatched in the previous spring from first egg to about the end of December. Thereafter the birds could be recorded for a short period in May or June, trap-nests again being introduced for a month towards the end of the first season's production.

Many breeders adopt this plan of trapping pullets for about the first three months of the laying year and again for about one month in August. Trapping in August will show which birds are still in lay, whether or not egg-shell strength has deteriorated and, of course, it will reveal the physical condition of the stock.

Estimating Egg Production without Trap-nesting. For commercial purposes a very fair estimate of egg production may be obtained by adopting a system of ringing.

The plan is as follows. Supposing a flock of pullets is housed at the end of September. At the end of October the flock should be handled, and all birds found to be in lay should be given a leg-ring of distinctive colour. In November the procedure should be repeated, using a ring of different colour, and again in December and January.

Birds laying consistently throughout the winter will then be identifiable, and if they moult late in the autumn it is safe to assume that they are good layers.

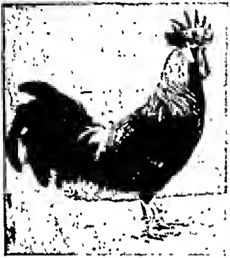
This system may be modified to suit individual circumstances. It is of great value where trap-nesting cannot be undertaken or the expense of trapping is unjustified. If numbered instead of coloured rings are used, more detailed information could be recorded, such as broodiness, body-weight and so forth.

Selection of Male Birds. The selection of stock cockerels is one of the most difficult tasks of the breeder, for on his choice will largely depend the success of his work.

It is commonly said that the cockerel represents 50 per cent of the breeding-pen. That is an under-statement. The male's influence on the progeny of all the hens with which he is mated is profound. He affects for better or for worse egg production, egg-size, hatchability, rearability and the viability of adult stock. He may be responsible for increasing resistance against disease, or he may cause greater susceptibility to it. An outstanding example of this occurs with fowl paralysis.

The real breeding value of a cockerel, in common with that of the hen, may be assessed only by progeny testing, and it is perhaps unnecessary to state that pedigree-breeders having tested males of high quality are reluctant to dispose of them except at prices beyond the reach of the average poultry-man.

That being so, in most instances purchasers are compelled to rely on the bird's pedigree—that is to say, the egg production of his dam and sire's dam and his family's record with regard



Photos: Modern Poultry Keeping

FIG. 60.—A REPRESENTATIVE OF HIS BREED

A Brown Leghorn sire of high utility quality.

FIG. 61.—A LIGHT SUSSEX LEADER

He can be "faulted" by the fancier but has many qualities that the commercial man seeks in stock cockerels. He is the descendant of a family fully pedigreed for many generations.

to health and other characters of economic importance. This information should be available for at least three generations.

The most reliable indication of a sire's worth is obtained from the records of his sisters. In the ordinary course of breeding practice cockerels, *i.e.*, first-season males, are most commonly employed. Therefore the *full production records* of sister groups will not be available; but part-records of sister pullets relating to their performance from housing time to the start of the breeding season should be studied. They will indicate most accurately the egg-production potential of the sires.

Whereas formerly few breeders retained male birds for two or more seasons, the use of proven sires is becoming increasingly common. They are the basis of some of the most successful breeding schemes designed for the production of both first-crosses and hybrids.

Whether the bird is fully pedigreed or not, handling and observation—especially observation—are necessary before a decision is made with regard to his suitability for breeding purposes. Neither males nor females can be wisely selected on their pedigree records, however satisfactory these may be.

FIG. 62.—A UTILITY BARRED ROCK COCKEREL OF THE TYPE THAT WILL APPEAL TO BREEDERS

Photo: Modern Poultry Keeping

FIG. 63.—A BARRED ROCK PULLET THAT SHOULD LAY WELL AND BE A WORTHY MEMBER OF THE BREEDING-PEN

The broad principles that are the basis of selection of the females apply equally to the males, allowing for the usual sexual differences.

Cockerels or cocks intended for the breeding-pen should be essentially masculine, with an abundance of bone, and depth and width of body. When taken in hand they should feel solid and show great strength. They should be free from physical defects. The breastbone should be stout and straight, although a bird having a slightly twisted breastbone should not necessarily be rejected, provided the breeder can be assured that the defect is acquired and is not due to an inherited tendency to soft bone. Similarly with regard to the toes: these should be

straight, but slight curvature is not a major defect if the bone formation as a whole leaves nothing to be desired

The body should be well proportioned and balanced, and the easy movement so characteristic of health and physical perfection in the female should be insisted upon for stock males The comb and wattles should be well developed, the eye bold and prominent, of good colour and free from structural defects The latter should at once condemn a bird for the breeding-pen

A good sire is a talkative, active individual He is constantly chattering, he will lead his hens about the pen, and in flock-mated pens the male having the greatest number of followers is usually the most vigorous He should crow frequently, loud and long, and resent interference with his mates

A good stock bird shows wonderful courage, not uncommonly attacking the attendant when handling the hens, and will challenge at once a strange cock that may approach the pen

Pugnacity is an indication of vigour, but the quarrelsome bird that makes himself a nuisance by attacking the attendant whenever he enters the pen is not necessarily a satisfactory breeder Some birds of this character seem to be more interested in fighting than in their hens, and occasionally these "fighting cocks" give very indifferent results Cockerels may transmit their aggressive disposition, and this may result in the progeny having a tendency towards feather plucking and cannibalism It is not wise to breed from birds that are constantly pecking their associates

The effeminate type of male should be sent to table He should not be used for breeding, however good his pedigree This type is unmistakable The birds show poor development of comb and wattles, the body is usually narrow and shallow, frequently they are in-kneed—*i e*, lack width between the legs They are quiet, rarely crow, do not lead their pen and usually decline to accept the challenge of other males The feathering is usually loose and lacks the lustre associated with good health

Age for Mating The precocious cockerel, like the precocious pullet, should not be used for breeding purposes Cockerels maturing at a very early age usually lack body size, and although they may give very high fertility for a time, they

frequently break down later in the season. Cockerels should be fully matured before they are used for breeding purposes—that is to say, seven or eight months old for light breeds, nine to ten months old for heavy breeds. When, however, they are sexually mature it is better to let them run with a flock of pullets or hens than to keep them in groups where fighting and "treading" will occur.

Some breeders in fact rear cockerels and pullets together. They do not separate the sexes at any age. Although this may be a "natural" method, it may result in bullying in some degree and exceptionally early mating. Nevertheless, it solves problems associated with flocks of cockerels.

If prospective sires are reared with pullets the latter should far out-number the former to avoid undue treading and bullying. In flocks of growers 8–10 cockerels per 100 pullets will have no detrimental effect on the stock.

Number of Hens per Cockerel. The number of hens to mate with the male bird to ensure satisfactory fertility depends on the individual and the conditions under which the birds are kept. On free range or in large pens the birds are more active than when kept in a small enclosure.

There has been a tendency to under-mate the males. A vigorous light-breed cockerel kept under good conditions, well fed and managed, will give high fertility with twenty to twenty-five hens, a heavy cockerel with fifteen to twenty hens. Instances of high fertility being obtained with even a larger number of hens are common.

A fertile, vigorous bird may be mated with three pens; pen A on Monday, pen B on Tuesday, pen C on Wednesday, and rested on Thursday, when the procedure may be repeated. In this way one bird may serve about forty-five hens. Very high fertility is commonly secured by adopting this practice.

It is far wiser to make the fullest use of the best males than to introduce somewhat inferior birds, which a low ratio of hens to cockerels frequently necessitates.

Factors Affecting Fertility. For years it was said that fertility was not inherited, that it was an individual character, not transmitted by sire or dam to sons or daughters. Recent work, however, suggests that fertility is inherited, although the degree of inheritance is low. Moreover, it is known that

many characters affecting fertility—for example, constitutional vigour—are inherited, therefore the breeder cannot afford to ignore it in the selection of his stock

There is a wide difference between the fertility of individual birds Some individuals of either sex may be sterile, others may give 100 per cent fertility. Experiments at the Northern Breeding Station, Cheshire, have shown that fertility is fairly constant throughout the season and from year to year, birds giving high fertility in their first year will usually maintain it in their second year if they are kept in breeding condition

This means that a breeder can dispose of birds giving low fertility early in the season with the knowledge that they are unlikely to improve later. The economic importance of this need not be emphasized Nevertheless, average fertility, even in highly fertile individuals of both sexes, tends to decline in the second and subsequent years The best layers are usually the most fertile

Should a bird considered of special value prove infertile with one male, however, she should be mated with another male before being discarded Fertility should not be less than 80 per cent

It is of primary importance to keep the stock in breeding condition—that is to say, lean, hard and active On no account should the birds be permitted to get over-fat and sluggish On the contrary, under-feeding is equally opposed to good fertility It is essential that the ration be fully adequate Should it be deficient, or unbalanced, as it is popularly termed, the condition of the stock will be adversely affected in direct proportion to the degree of unbalance, and fertility will be affected accordingly

Cold weather, especially when accompanied by strong winds, results in lower fertility, because under these conditions the birds are less active Breeding stock should be given reasonable protection while on range

In foggy weather and during the short days of mid winter it is advisable to include 1 per cent of cod liver oil in the ration to furnish vitamins A and D

During the summer months shade should be provided Long exposure to the blazing heat of the sun will cause the birds to lose condition

Dubbing. This means the removal of the comb. Males having large single combs should be dubbed in order to avoid frost bite and to diminish the risk of injury due to fighting or accident.

It is an aid to fertility because it prevents loss of condition arising from the above factors.

The operation is quite a simple one, and is not cruel if properly carried out. An assistant should hold the bird with its head on a table. Then with a sharp knife or razor the comb is removed, cutting from back to front, not too close to the skull.

Photo: Modern Poultry Keeping

FIG. 63.—A DUBBED BROWN LEGHORN COCKEREL

The wattles may be cropped at the same. The work should be done on a warm day. In cold weather it is more difficult to prevent excessive loss of blood.

After dubbing, the bird's head should be held under the cold-water tap for a minute or so to check bleeding (care being taken not to drown the bird), and the raw surface then dressed with Friar's Balsam or flour. The bird should be isolated until bleeding has ceased. Recovery is rapid.

Dubbing causes far less suffering than frost-bite. It is of considerable value in maintaining high fertility with single-comb males. The operation is usually carried out in the autumn before the birds are mated. There will be less loss of blood, however, if the comb is removed when the cockerel is about 10 weeks old. It is practicable to dub at day old. Some

breeders remove the comb of baby chicks with curved scissors

De-spurring Second-year or older males should have the spurs shortened It is necessary to remove only the horny tip This causes no pain

The tip of the spur may be burned down with a red-hot poker, care being taken not to burn the shank As a precautionary measure a piece of damp cloth may be placed round the base of the spur

Some breeders shorten the spurs with a chisel or wire cutters Others force a hot baked potato on the spur, leave it there for a few minutes to soften the horn, which can then be removed

Breeding stock should have clean, roomy, well ventilated houses, where they can be kept free from insect pests

Any factor having an adverse effect on the health of the flock will cause loss of fertility to a greater or lesser extent

Duration of Fertility. When the male bird is removed from the pen good fertility is maintained for a week, and then begins to decline By the tenth day only about 50 per cent of the eggs are fertile, and by the nineteenth day only about 15 per cent, although fertile eggs may occasionally be produced up to the twenty sixth day Crew reported that a fertile egg was laid thirty-two days after the removal of the male

When a pen is first mated, fertile eggs will be produced as early as the second day, but it is advisable to wait six or seven days to ensure maximum fertility The earliest recorded case of fertility after mating is about twenty hours

Hutt (1949), in experiments in breeding for resistance against lymphomatosis at Cornell University, has adopted a system of double and triple shifts in order to secure more proven males, each set of males being used for part of the breeding season only The triple shift enables three times the number of males to be tested in a season, compared with the use of a single set of males throughout

After the first males are taken from the pens eggs are credited to them for the next five days On the fourth day after the removal of the first males the second males go into the pens in the late afternoon Eggs laid the following day are credited to the first males

For six days following the fifth day after the first males are

removed the paternity of the eggs is doubtful and they are marketed. Eight days after the introduction of the second males, *i.e.*, twelve days after the removal of the first, all eggs are credited to the second males.

The same procedure is followed with a third set of cockerels.

The above refers to natural matings. With artificial insemination Hutt found that the change of paternity was effected more rapidly. At least 97 per cent of the chicks were sired by the new males after the third day following insemination.

Hatchability. Birds of high vitality give high hatchability; similarly, loss of vitality, which usually takes a slowly progressive course, reveals itself in lower hatchability. It is no exaggeration to say that selection for hatchability is one of the most important steps in any scheme for stock improvement.

The breeder should keep accurate records of the hatchability of males and females, and should at once remove from the breeding-pens all birds that show that their eggs carry a lethal factor or produce abnormal chicks. This work is fully justified, even if only the current breeding season is considered, but, since hatchability is an inherited character, the cumulative effects of selection are of the greatest economic importance. Hatchability should not be less than 65 per cent of all eggs set, or 85 per cent of fertile eggs.

On some farms hatchability is about 80 per cent of all eggs set. National average is probably about 70 per cent.

It must be emphasised, however, that nutritional and other environmental factors affect hatchability to a marked degree. Many of the complaints of low hatchability received every season are in fact due, not to inherent weakness, but to an inadequate diet. When a well-known geneticist was asked what he would do if hatchability in a flock were low, he said he would first consult a nutritionist.

This reply indicates the importance of ensuring a complete diet for stock birds. As will be noted in Chapter Fifteen, many factors influence hatchability, and it should be seen that the birds are able to obtain adequate amounts either in the food supplied to them or in what they find on range.

Viability. This factor, like hatchability, is an inherited character, and therefore can be improved by selection. Every

poultry-man is aware of the great difference in the viability, or ability to live, of birds of different strains reared and kept under identical conditions of feeding, housing and management.

The extent to which the breeder is responsible for viability is clearly demonstrated by statistics from the laying trials. Here every factor is constant, with the exception of breeding. It is shown that mortality is not evenly spread over the competing pens. There are some pens in which mortality is extremely heavy, some in which moderate losses occur, while in others there are no losses.

This is conclusive evidence that viability is primarily a breeder's problem. To attribute it to systems of management and feeding is contrary to facts brought to light at laying trials and experimental centres the world over. This does not imply, of course, that errors in management will not cause mortality by lowering the resistance of the stock. Indeed, a considerable proportion of losses among chicks, growers and adult birds arise from bad management. But high mortality is inevitable if the stock is weakly, if it lacks normal resistance to those common diseases to which it will be exposed in the ordinary course of farm management.

Every pedigree-breeder should keep records of mortality among the progeny of each male and female in the breeding-pens, and discard for breeding purposes all birds whose progeny fail to show a high degree of viability. This should be done with the utmost severity: indeed, it is impossible for the breeder to set himself too high a standard in this respect.

Chapter Seven

Systems of Breeding

Cross-breeding. Cross-breeding refers to the mating of two distinct breeds. It is commonly practised by commercial breeders for the production of laying stock and table birds.

It results in the combination of many different genes, and, since desirable characters are usually dominant, they express themselves in the progeny of first crosses. Consequently the birds produced by cross-breeding are frequently superior to their parents because they inherit and express the more desirable qualities possessed by sire and dam.

The most apparent effect of cross-breeding is improved vigour. This is termed hybrid vigour or heterosis to denote that it is obtained by the cross-mating of two distinct breeds. When cross-breeding, the progeny tend to inherit a double dose of the factors responsible for vigour, which are dominant. If they were not, then the race would soon become extinct.

While the advantages of cross-breeding are widely recognized, it should be emphasized that the qualities of the cross-bred birds depend on those of the parents. They can only inherit the factors possessed by the parents, and therefore if cross-breeding is to serve a useful purpose the parent stock must be carefully selected for the characters the breeder desires to produce.

Indiscriminate cross-breeding is valueless, and it is useless to suggest crossing two breeds merely for the sake of crossing. An inferior strain of one breed crossed with an inferior strain of another will produce inferior progeny. The birds must be selected with as much care as when breeding pure-bred stock, with the exception only of breed points. While crossing is recommended for commercial purposes, it is not wise to continue crossing different breeds year after year. If this were done the progeny would become more and more heterozygous, and therefore selection progressively less effective, since eventually one would produce mongrels in every sense of the term.

Such breeding policy if it can be so called would result in undesirable traits becoming manifest.

However, the practice among commercial breeders of maintaining two or three pure breeds and using the birds that fail on breed points for cross-breeding is undoubtedly sound.

To-day the majority of commercial breeding flocks are mated for the production of crosses. A large proportion of the eggs from these flocks are sent to hatcheries, which now probably supply 75 per cent of commercial replacement stock.

The importance of improving the quality of hatchery suppliers' flocks will therefore be recognized. The leading hatchery firms are aware of the need for up-grading these flocks; some hatcheries have established their own breeding-farms, primarily with a view to providing their suppliers with males of superior quality.

Unfortunately, some of the sires with which the commercial breeding flocks are mated are not of the highest grade, and in fact they are of unknown origin in the breeding sense. Frequently cheap cockerels from the commercial flocks or perhaps from the same flock are mated, or the breeder while purchasing pedigree sires may obtain birds from different breeders every year.

If the quality of the laying flocks is to be improved it is essential to up-grade the breeding-pens that produce them, and the simplest, most practical means of achieving this objective is by the use of high-quality pedigree sires of known family history.

Lippincott (1920) in his classic experiment demonstrated the superiority of the well-bred sire.

Starting with a flock of pullets of farm origin, by the use of pure-bred sires from commercial breeders, in three generations he raised the average egg production in quite a spectacular manner as shown in the following table:—

TABLE 12

Effect of Up-grading Farm Flocks with Pedigree Sires (after Lippincott)

Cockerels	Parents	First generation	Second generation	Third generation
White Leghorn	72.3	155.9	188.6	192.6
Barred Rock	98.5	132.5	140.6	155.6
White Orpington	84.5	126.8	105.8	79.6
Mongrel	95.8	104.0	115.2	129.6

Such breeding policy if it can be so called would result in undesirable traits becoming manifest.

However, the practice among commercial breeders of maintaining two or three pure breeds and using the birds that fail on breed points for cross-breeding is undoubtedly sound.

To-day the majority of commercial breeding flocks are mated for the production of crosses. A large proportion of the eggs from these flocks are sent to hatcheries, which now probably supply 75 per cent of commercial replacement stock.

The importance of improving the quality of hatchery suppliers' flocks will therefore be recognized. The leading hatchery firms are aware of the need for up-grading these flocks; some hatcheries have established their own breeding-farms, primarily with a view to providing their suppliers with males of superior quality.

Unfortunately, some of the sires with which the commercial breeding flocks are mated are not of the highest grade, and in fact they are of unknown origin in the breeding sense. Frequently cheap cockerels from the commercial flocks or perhaps from the same flock are mated, or the breeder while purchasing pedigree sires may obtain birds from different breeders every year.

If the quality of the laying flocks is to be improved it is essential to up-grade the breeding-pens that produce them, and the simplest, most practical means of achieving this objective is by the use of high-quality pedigree sires of known family history.

Lippincott (1920) in his classic experiment demonstrated the superiority of the well-bred sire.

Starting with a flock of pullets of farm origin, by the use of pure-bred sires from commercial breeders, in three generations he raised the average egg production in quite a spectacular manner as shown in the following table:—

TABLE 12

Effect of Up-grading Farm Flocks with Pedigree Sires (after Lippincott)

Cockerels	Parents	First generation	Second generation	Third generation
White Leghorn	72·3	155·9	188·6	192·6
Barred Rock	98·5	132·5	149·6	155·6
White Orpington	84·5	126·8	105·8	79·6
Mongrel	95·8	104·0	135·2	129·6

Chapter Seven

Systems of Breeding

Cross-breeding. Cross-breeding refers to the mating of two distinct breeds. It is commonly practised by commercial breeders for the production of laying stock and table birds.

It results in the combination of many different genes, and, since desirable characters are usually dominant, they express themselves in the progeny of first crosses. Consequently the birds produced by cross-breeding are frequently superior to their parents because they inherit and express the more desirable qualities possessed by sire and dam.

The most apparent effect of cross-breeding is improved vigour. This is termed hybrid vigour or heterosis to denote that it is obtained by the cross-mating of two distinct breeds. When cross-breeding, the progeny tend to inherit a double dose of the factors responsible for vigour, which are dominant. If they were not, then the race would soon become extinct.

While the advantages of cross-breeding are widely recognized, it should be emphasized that the qualities of the cross-bred birds depend on those of the parents. They can only inherit the factors possessed by the parents, and therefore if cross-breeding is to serve a useful purpose the parent stock must be carefully selected for the characters the breeder desires to produce.

Indiscriminate cross-breeding is valueless, and it is useless to suggest crossing two breeds merely for the sake of crossing. An inferior strain of one breed crossed with an inferior strain of another will produce inferior progeny. The birds must be selected with as much care as when breeding pure-bred stock, with the exception only of breed points. While crossing is recommended for commercial purposes, it is not wise to continue crossing different breeds year after year. If this were done the progeny would become more and more heterozygous, and therefore selection progressively less effective, since eventually one would produce mongrels in every sense of the term.

different breeder every season, it will be wiser for him to work in closer collaboration with the breeder whose stock is known to do well on his (the purchaser's) farm The pedigree-breeder knows the strain with which his customer is working, he knows its good features and its bad ones, and is therefore in a much better position to supply the most suitable birds for mating with it than another breeder working with an entirely different family in an entirely different environment

It should be obvious that the breeder who supplied sound stock is the best man to keep it sound, and it is unfair to the pedigree-breeder to use his strain for indiscriminate out-crossing Such a practice cannot lead to improvement because, from a genetical standpoint, it results in mongrelizing the strain The birds are no longer " pure " for those characters the breeder has established

The value of closed-flock breeding in excluding undesirable and intensifying desirable tracts is now widely recognized It has become common practice among pedigree breeders operating on a sufficiently large scale to enable close in-breeding to be avoided Pedigree breeders with small flocks and commercial breeders can adopt the closed-flock system by confining matings to a selected strain

Criss-cross Breeding. This refers to breeding from first-cross hens for the purpose of exploiting heterosis while avoiding the more costly procedures involved in the production of " hybrids ".

It is well known that crossing between breeds usually results in improved hatchability, chick viability (not adult viability), growth and egg production Breeding from crosses has the same effects, and subject to due care in selection of the parent stock, it can be relied upon to produce birds of high quality

Criss-cross breeding should be more commonly practised It enables the breeder to keep first cross females only, and as they are usually superior layers they can be expected to produce more chicks per breeding hen than pure stock

It is, of course, imperative that the first cross females used for breeding should be the descendants of pedigree strains, for the commercial value of the progeny depends on the genetic qualities of their parents

Males should be pure bred and should be members of families

New males from the same source were used each year (except the last in the case of the Barred Rock) The mongrel sires were purchased from a packing-house

It cannot be said that the White Orpington was improved, but there is no doubt about the improvement in White Leghorns and Barred Rocks The failure with the Orpington was attributed to insufficient breeding for egg production

The improvement in the mongrels may be due to environment, but this factor would be common, and in no way affects the validity of the experiment

Out-crossing Out crossing is the mating of individuals of different families of the same breed It is the most commonly practised system of pure breeding probably because it is the simplest

Its primary purpose is to avoid the ill effects of in breeding but buying new blood from different breeders every year presumably with the object of securing the good features of every family while excluding the bad, is not a policy that can be recommended

Frequently very undesirable characters have been introduced in this way The use of a cockerel from a certain strain may have disastrous consequences, even though the bird may have no visible defect and his family history may be entirely satisfactory This is due to the recombination of the numerous factors transmitted by the parent birds and is capable of Mendelian explanation

The practical man usually explains the unsatisfactory results by stating that the mating failed to "nick"—in other words the genes failed to combine in the manner anticipated

It is possible for the breeder who relies upon out crossing to continue successfully for many years but the danger of introducing an undesirable character is ever present, and sooner or later trouble usually arises from following this course Indeed it would be somewhat remarkable if it did not, since repeated out crossing results in the accumulation of such a heterogeneous mass of characters from the different strains that in course of time one that is undesirable will almost certainly express itself

This danger cannot be avoided but it can be reduced very considerably by breeding within the strain as far as possible

Instead of the commercial man purchasing new blood from a

Importance of Family In breeding it is said that "it is the individual that counts" That is perfectly true The individual must be considered when selecting birds for the breeding pen Experiments and the work of breeders who carry out progeny testing, however, have shown that there is something more than individual selection involved if progress is to be made in establishing strains capable of giving high average egg production and showing low mortality It is necessary to consider the bird's family history

To-day far more importance is attached to family records than formerly These are, in fact, becoming the basis of selection on an ever-increasing number of pedigree farms, and it is interesting to note that the Canadian scheme for stock improvement—the Record of Performance—is concerned with the performance of the family, not individuals

It is commonly assumed that the higher the record of the dam, the higher that of the daughters This assumption is not well founded because all high-record dams do not produce high record daughters The dam's record is in fact not a reliable measure of her breeding worth although it must not be disregarded

It is clear that if the pullet-year record of egg production were an adequate basis for selection, then the maintenance of high egg production in the progeny would no longer be a problem Breeders have been selecting on this basis for many years, yet they have found, as Gowell found over fifty years ago, that it will not lead to an increase in production in each successive year

Selection by individual performance is very effective in improving the average egg production of flocks of poor or medium quality, but eventually a point is reached beyond which further progress, taking the average of the seasons, is not achieved Egg production reaches its ceiling at about 200–220 eggs per bird, and it is with the object of breaking through the ceiling or barrier as it is often called that newer methods of selection are applied These are based on the performance of the flock or family, and at the same time the value of heterosis is exploited to give a further impetus to egg production

With traits that are of high or fairly high heritability the most rapid improvement will be effected by individual selection,

whose records over at least three generations show a high standard of health and egg production. In no circumstances should cross bred males be used, for this would increase the risk of the progeny proving inferior to the first cross.

Skaller (1954) reported the results of an experiment in criss cross breeding with White Leghorns and Black Australorps at the Poultry Research Centre, Victoria, Australia. He found that the criss cross bred pullets showed the same amount of heterosis, as expressed in better hatchability, lower chick mortality and higher egg production as the first cross. There was no significant difference in adult mortality.

Pedigree-breeding. The term pedigree is often loosely applied by poultry-men. For many years it referred almost exclusively to the egg record of the dam and the sire's dam, and possibly to that of the grand dam and sire's grand dam.

Such records are, of course, concerned only with egg production. Nevertheless, they were at one time regarded as adequate by the average man, whose work in the pedigree field was mainly directed towards raising the average egg production of his flock.

The public demanded high-record birds, and the breeder who could produce the most prolific layers was able to obtain the highest prices, so the scramble after egg records began. For many years other characters were given little attention, and as a result of selection for egg production only the birds lost body-size and vigour. In the 1930s the rate of mortality among growing and adult stock began to rise to an alarming extent. Although some improvement has now been effected, much more remains to be done before the position can be regarded as satisfactory.

Looking back, it is rather remarkable that throughout this time relatively few breeders took steps to ascertain the quality of the stock their birds were producing. Generally speaking, breeders laboriously trap-nested the layers during the first season's production, and if the pullet year record was sufficiently high they were mated in their second year with cockerels from high record dams.

No attempt was made to secure information regarding hatchability, rearability and the record of performance of the sons and daughters of individual birds. The majority of breeders did not test the progeny.

produce strains having high resistance to a specific disease This implies, of course, that he should eliminate all families in which high mortality has occurred where there is reason to believe that it is attributable to inherent weakness

It is now widely recognized that the family, not the individual, must be the basis of selection for health and for egg production at the higher levels Indeed, progressive breeders are not only selecting stock by family performance, they are also selecting the best birds from the best families and progeny testing strain or family crosses to discover the most successful matings

Older methods which depend on visible characters of the birds and the trap-nest records of the dams, useful as they undoubtedly are, will not solve the problem of passing the present barrier at the 220 egg level and producing highly prolific strains in large quantity

Assessing Viability of Family Jull (1945), in a paper distributed to all Canadian breeders in the Record of Performance scheme, discusses the selection of breeding stock with the object of reducing mortality among the progeny He referred to experiments carried out a few years ago by K T Wright, Michigan Experimental Station The results show a close correlation between the mortality among growing chicks and that of pullets during their first laying year. Flocks having an average growing-chick mortality of 7 per cent had a laying flock mortality of 7 3 per cent, flocks showing growing chick mortality of 14 per cent had a pullet mortality of 15 2 per cent, while flocks having chick mortality of 27 7 per cent had a laying-pullet mortality of 28 2 per cent

Jull then referred to experiments by Miss Cook, of the Minnesota Extension Service She kept records for ten years, and observed that (1) growing-chick mortality of 13 per cent was followed by laying-flock mortality of 16 per cent, (2) growing-chick mortality of 15 per cent was followed by laying-flock mortality of 20 5 per cent, and (3) growing chick mortality of 17 per cent was followed by laying-flock mortality of 29 per cent

Mueller, who analysed data supplied by Hutt, Cornell University, has shown that mortality during the rearing period is closely related to that among laying pullets when determined on a family basis The rearing period included the period

whereas with those characters of low heritability the most rapid improvement will be made by family selection. The principal characters of high, medium and low heritability are shown in the following table:—

TABLE 13

Heritability of Characters of Economic Importance

High heritability.	Medium heritability.	Low heritability.
Body weight . .	Rate of growth	Viability
Egg weight . . .	Meat/carcase ratio	High egg production
Shank length . .	Pauses in egg production	Fertility
	Egg quality	Hatchability

It is, of course, by no means certain that good progeny will result from family selection, but of two birds of equal first-year record, one that is a member of a large family of good layers, the other of a family of poor or moderate producers, the chance of producing first-class progeny from the former is infinitely greater than from the latter.

The same principle holds good in the selection of male birds. In families of high egg-production records, however, the record of the dam is not a reliable indication of the ability of the sire to raise the average production of his progeny. For example, a sire from a 270-egg dam of a high-egg-production family may prove inferior to a sire from a 210-egg dam. In the higher egg-production groups the probability of a sire improving the production of his progeny is less than if he were mated with birds of lower egg records.

But this also applies in the selection of the dams. The higher up the egg-production scale a breeder goes, the more difficult progress becomes and the greater the need for progeny testing in order to secure it.

Selection by the family is equally important in breeding for livability. It is possible by selection to build up families having great resistance against specific diseases, as shown by Hutt and his co-workers in their experiments in breeding for resistance against fowl paralysis. In practice, breeding for resistance against a specific disease is costly, and in view of present knowledge it is wiser for the breeder to aim at building up the general health of the stock rather than to attempt to

mortality occurring among the daughters of a sire from housing time to January 1st was practically as good an index of his ability to transmit viability as the mortality among his daughters up to 500 days old

These observations are of considerable value to the pedigree breeder, because they indicate a means of selection less exacting than testing all the progeny Yet they give the breeder the assurance that he is selecting birds that are likely to improve the viability of his strain

A point often overlooked by breeders who continually buy stock from different farms is that of environment It does not follow that birds showing high livability on their native farm will prove satisfactory when removed to another where environmental factors may be different

An example of the effect of environment was shown by Brown Leghorns at the University of Edinburgh, where no case of fowl paralysis was seen In 1937 hatching eggs were sent to Rowett Institute, when over 63 per cent of the University birds from the eggs supplied died from fowl paralysis The University stock proved susceptible to this disease, but remained healthy in their native environment because they were not exposed to infection

In-breeding. In-breeding refers to the mating of closely related individuals The closest relationship is that of full brother to full sister, the next closest father to daughter or mother to son

As a general rule this system of breeding should be avoided, although the pedigree-breeder may occasionally practise it The man who is working on pedigree lines may be fully justified in close mating in certain circumstances He may do so in order to establish, or attempt to establish, a specific character If he fails, the line is not propagated further, because he has his birds under complete control The breeder who does not apply pedigree breeding methods cannot do this, because he is unable to identify the progeny He may therefore propagate undesirable characters and distribute them throughout this flock before his error becomes apparent

In-breeding brings together both undesirable and desirable characters Many undesirable characters are recessive, but when in-breeding, these combine, and thus find expression

from forty three to 160 days of age, and Mueller suggests that resistance against disease at this stage is related to similar resistance in the early laying period

From this it is concluded that by keeping mortality records of the progeny of sires from the seventh week to five months of age, the breeder could eliminate at housing time those families of pullets that had incurred high losses previously, with some assurance that he was disposing of the birds least likely to survive through the laying year

A similar state of affairs is revealed by an examination of data regarding the sires' families, but it was found that mortality up to forty three days was not correlated to subsequent mortality

It is therefore clear that the breeder can obtain a fairly accurate measure of adult mortality in a given family from the rate of mortality among growing stock between forty three and 160 days old

Mueller s analysis also shows that dams that died relatively late in life produced daughters having higher viability than the daughters of dams that died at an early age

This result corresponds with that obtained at Cambridge, where experiments have shown that the mortality among the progeny of pullets that died during their first laying season was greater than that among the progeny of pullets that survived and among older birds

This, of course, is the best answer to the question of pullet breeding It shows that the danger of breeding from pullets of healthy families has been exaggerated, it emphasizes the grave risks involved in breeding from pullets of unknown family history

Commenting further on Mueller's analysis, Jull said ' When mortality of daughters between 161 and 500 days of age was considered it was found that the amount of mortality among the first thirty daughters produced by a sire was practically as good an index of his ability to transmit viability as the amount of mortality among all his daughters The same situation was found to be true with respect to resistance to neoplasms

Jull pointed out that data on pullet mortality up to January 1st could be used as a guide in selecting both cockerels and pullets for breeding purposes, because it was found that the

first few generations As compared with out-bred controls, they laid fewer and smaller eggs, they were slower to mature and were of lower body-weight Then followed a partial recovery, and although the in-breds continued to give rather lower egg production than the controls, a measure of uniformity in production from generation to generation was secured

The Northern Breeding Station was closed in 1959

Line-breeding. The term denotes the restriction of mating to one line of descent, the progeny having common ancestors It is a form of in-breeding designed to avoid the mating of very closely related individuals—*e g*, mother and son, father and daughter

Line-breeding demands considerable skill and complete control of the progeny of each mating Unless control is maintained a breeding programme based on it will assuredly break down

In the hands of the skilled breeder line-breeding has much to commend it. It avoids the necessity for the repeated introduction of new blood from other strains, which, despite the most careful selection, may have a detrimental effect, because it may introduce undesirable characters This very frequently occurs in practice, because the mating of two equally good strains or families does not necessarily produce progeny of the same quality as the parents

In order to avoid the need for the constant introduction of new blood, with all its attendant risks, line-breeding is being adopted on an ever-increasing scale by pedigree-breeders

They start with, say, four, five or six distinct lines or families, and by ringing the changes in mating they can carry on for years, if not indefinitely, without seeking fresh blood By this method close in-breeding can be avoided

The success of the system, in common with all other methods, depends entirely on the breeder's skill in selection He must be able to recognize any weaknesses that are beginning to express themselves and take the necessary steps to eradicate them He must seek to develop in his various lines the characters he requires, buying from outside sources only when he wants a character that he cannot find among his own birds

Top-crossing. While the above experiment was in progress the spectacular results obtained in America by top crossing

in the progeny. They can be eliminated only by selection.

Many experiments have been carried out in in-breeding. They have shown that during the first few years there is a progressive deterioration in the average quality of the progeny, on account of the undesirable factors present in the original stock. If, however, the family does not peter out in the process of getting rid of unwanted characters, the breeder may eventually establish a strain genetically pure for some of the characters he requires. That is the theory of close and persistent in-breeding, but it rarely, one may say never, succeeds in the field of practice.

With families that will withstand in-breeding, greater uniformity of some characters may be secured, but so far as egg production is concerned in-bred flocks produce at a lower level than the original lines. The progeny of sister-brother matings are known as "sibs".

While intensive in-breeding is not commercially justified—indeed, the heavy losses would soon put the breeder out of business—limited in-breeding followed by crossing the in-bred lines has been shown to be of value, and is referred to below.

In-breeding Experiments: At the Northern Breeding Station, Reaseheath, Cheshire, close in-breeding—*i.e.*, continuous brother-sister mating was practised for many years from 1933.

Work was commenced with White Leghorns, White Wyandottes, and Rhode Island Reds—twenty pens in all. But in-breeding revealed so many undesirable factors that after five years only one line of White Leghorn was of sufficiently good quality to warrant further breeding. The families petered out as a result of general loss of vigour and inability of the progeny to thrive and breed.

This result is a common one in experiments of this kind, but it must not be assumed that any given set of families will behave similarly. Some strains are able to withstand in-breeding better than others, and a breeder may be more or less fortunate than the workers at Reaseheath. In 1936 there were only four survivors of the in-bred family of White Leghorns.

Further in-bred lines were subsequently established, and it was again found that the in-breds deteriorated rapidly in the

Line chick The method is a combination of in breeding and recurrent selection

As new outstanding in-bred combinations are discovered, the inbred parent-lines are then multiplied in mass matings

All of the commercial varieties are produced by first crossing in-breds to make the male and female parents of the final product That means more vigorous parents than there would be if an in-bred were used as a parent in the final cross

Operations are conducted on a vast scale There are some 1,100 farms co operating with the four experimental farms where in-breds are produced at the centre of the organization

More than 500 pens are used twice annually in the development of new in-bred lines Well over 100,000 in bred chicks are wing-banded each year as part of the experimental programme, but less than 10 per cent of them ever find their way into subsequent breeding-pens The other chicks either die or are discarded

In addition, over 1,200 pen matings of in-bred crosses are made each year in an attempt to discover new combinations which are superior to present commercial Hy-Line varieties More than 50,000 pullets are trap nested on farms scattered all over the United States as part of this testing programme

The in-bred single cross parent stock which produce the final commercial Hy-Line chick is reared by parent flock cooperators scattered over the United States, Canada, many parts of Latin America and most of free Europe

These flock-owners have males which are crosses of other in-bred lines

The hatching eggs are sent twice weekly to hatcheries distributing Hy-Line chicks and are either incubated or shipped to associated Hy-Line hatcheries

For some years work was done mainly with White Leghorn, Rhode Island Red and New Hampshire, but in recent times emphasis on feed-conversion efficiency and the white egg has resulted in more extensive use of in-breds of light-breed origin About 95 per cent of the present output consists of birds of this type, only 5 per cent being combinations of in-breds of light breeds and heavy breeds

The cost of this breeding programme has been enormous, but

maize attracted considerable attention Top-crossing means the crossing of males from highly in-bred lines with out-bred commercial stock, and it was suggested that the method may be equally successful when applied to poultry

At the eighth World's Poultry Congress (1948), Dudley and Pease presented a paper on this work which stated that "in this experiment top-crossing showed no advantage over out-crossing and it does not, as a method of breeding, offer any solution to the problem of improving the already good".

In 1944 crosses were made between the five in-bred lines of White Leghorns at Reaseheath The lines have been crossed in almost every combination

In the method of crossing in bred lines adopted by Wallace the in-bred lines which are successful are crossed and the progeny of successful matings are again crossed Wallace is crossing in-bred lines of different breeds, whereas at Reaseheath the work was done with one breed

Production of Hybrids, Crossing In-bred Lines Crossing in-bred lines is adopted commercially in the production of the well-known Hy-Line chicks This poultry-breeding project was financed by the Pioneer Hi-bred Corn Company, Iowa, U S A, and the breeding methods employed were described by *H B* Wallace, Junr, when he visited this country in 1949

In-breeding on a large scale was commenced by the Company in 1936, with eggs from first-class strains from about fifty breeders, but stock from 100 or more sources has been tested over the past twenty years Most of the stock proved worthless A few strains have stood up unusually well under in breeding As a rule, it is found that the best pure strains produce the best in-breds

Birds of different strains and breeds are closely in-bred (mainly brother sister mating) for three or four generations The wastage during this period is heavy, because in breeding shows that many lethal factors are present, and, as a consequence, many lines peter out in the higher stages of in-breeding

The lines which prove satisfactory are highly homozygous for those characters of commercial value for which they are selected Successful in-bred lines are then mated together (in crossed) The successful crosses, *i e*, the two way crosses, are then mated together to produce the four-way cross—the Hy-

the difference was maintained during the forty-four-week laying period. Average egg size was greater in the out-bred stock.

A very different story was told with regard to egg production. Taken as a whole, the in-crosses " laid substantially better than the controls in every year. . . . Taken separately, 12 in-crosses laid significantly better (6 very substantially better) than the controls."

The experiment showed that " so far as egg production within a single breed is concerned but not in respect of any of the other characters examined, preliminary in-breeding accentuates the heterosis effect in most in-crosses and in a few to an extent which shows that this method of breeding has promise for commercial breeders."

The investigators could find no means of predicting successful in-crosses from the performance of the in-bred parents.

TABLE 14

Comparison of In-cross and Out-cross Stock (Pease and Dudley (1954), Northern Breeding Station)

Year of hatching	Age at sexual maturity (days).		Weight at sexual maturity (gm.).		Egg weight (gm)		Egg production in 308 days (44 weeks)	
	In-cross.	Out-cross.	In-cross	Out-cross	In-cross	Out-cross	In-cross	Out-cross
1944	200	196	1790	1880	56.8	59.4	158	157
1945	208	200	1710	1900	57.5	58.8	159	154
1946	190	194	1800	1830	57.2	56.4	153	143
1947	190	190	1780	1990	56.8	59.9	193	178
1948	187	189	1830	1930	56.0	56.8	189	176
1949	174	176	1780	2020	55.2	58.7	193	161
1950	183	183	1780	2120	56.8	61.0	189	180
1951	180	173	1800	2220	56.7	63.3	183	168

Reciprocal Recurrent Selection. Despite the outstanding success of certain hybrid strains resulting from crossing in-bred lines, in-breeding is not a prerequisite to the production of superior hybrids. There are other means of harnessing heterosis that can be employed which do not entail the high cost of in-breeding.

One, reciprocal recurrent selection, is being applied on an

there is no doubt that it has been successful in yielding a more productive pullet than that obtained by orthodox commercial methods

The hen-housed average production on diversified farms is about 195 eggs High flock records range up to over 300 eggs, with most flock owners of commercial size reporting more than 230 eggs per bird housed

(The hen-housed average production is the average based on the number of birds originally housed, no allowance being made for subsequent culling or mortality)

Hy-Line chicks sell at about double the price of the average hatchery chicks. Over 16 million Hy-Line chicks were sold in 1950, over 30 million in 1956 and over 70 million in 1959

Chicks produced by this method should not be used for breeding purposes, because crossing them again would result in a recombination of the good and bad genes of the parent in-breds, so that an F2 population could be expected to perform only about 80 per cent as well as an *F1 population*

While no poultry geneticist will deny that, properly applied, in-breeding is of value, many breeders have questioned whether the extremely high cost is justified

Wallace (1959) [1] stated "In recent years it has become evident that the in-bred-hybrid breeder is in the best position to take advantage of the new and complicated techniques such as blood typing. We have pioneered in this field and feel success is possible only through the high degree of genetic control afforded by inbreeding"

Pease and Dudley (1954) compared the performances of in-crossed pullets (*i e*, pullets bred by crossing in-bred lines of the same breed) with the performances of out-bred pullets bred from thoroughly heterozygous parents The object of the experiment was to show whether or not preliminary in-breeding increases the heterosis effect either generally or specifically in certain in-crosses

In general, results showed that there was nothing to choose between in-crosses and out-breds as far as age at sexual maturity was concerned In most cases in-crosses were of lower body weight at sexual maturity than the control (out-bred) stock,

1 Personal communication

each of a few hundred birds could adopt the system, while the small breeder could co operate with another in a similar position, each carrying out his share of the strain-testing programme

When first advocated, this method of producing hybrids was regarded in some quarters as superior to all others It is undoubtedly of great value, but experience has shown that its advantages have been exaggerated It is not the complete solution to the problem of producing superior hybrid strains On the contrary, some investigators have found that strain crossing is an equally efficient method

It is significant that breeders do not confine themselves to this method of selection, although they may make much use of it

Successful breeders of the newer hybrid strains are naturally reticent with regard to their procedure in selection It is evident that there is more than one way of reaching the common objective. No one can yet say that any method of selection is superior to all others

Selection by Population Statistics. A method of selection based on statistical information concerning families is practised at the University of California by I M Lerner and his co-workers

In the course of about twelve years, by selecting families by their hen-housed average egg production, the egg production of White Leghorns used in the investigations at the University has been raised from 120 to 220 eggs per bird

In 1945, however, there was a slight reduction in average output to 214 eggs per bird, and in 1946 to 204 In 1947 there was an upward turn to 207 eggs per bird, and in 1948 there was a production index of 224·7 eggs per bird Since 1941 the flock has been closed but close inbreeding has been avoided

It may be said that this improvement is not remarkable and could have been obtained by up grading in considerably less time That is so, but during this period better sires have been bred, as well as better layers

Briefly, the method consists of trap-nesting pullets from the time of starting to lay in September until 1st January Selection is then made on the basis of family production—*i e*, sister records—and the best families judged by the hen-housed average production (Production Index) are subsequently bred from, using males from families similarly selected

ever-increasing scale in the production of hybrids, it is an officially recognized system of breeding hybrids

The method described by Jull (1952) is designed to ensure the greatest degree of hybrid vigour (heterosis), while avoiding intensive in-breeding in producing the parent stock It is a test for "nickability" of one strain with that of another, and it identifies strains whose genes combine most effectively

In the first year, strain A males are mated with strain B females and strain B males with strain A females

Records of egg production and viability of the progeny of these matings are kept on a family basis

Strain A males and females that produced the best progeny when crossed with birds of strain B are then mated together, similarly, strain B males and females that produced the best progeny when mated with A strain are also mated together to reproduce strains A and B, respectively

The progeny of the first matings, A × B, B × A, are not used for breeding purposes In the first year, strains are crossed, in the second, the best families of strain A are crossed and the best females of strain B, in the third, matings are made between the strains as in the first year

RECIPROCAL RECURRENT SELECTION

First Year Matings

A Males × B Females — B Males × A Females

PENS 1 2 3 4 5 6 to 20 — 31 32 33 34 35 36 to 50

Cross-Strain Progeny Performance: Best (3), Second Best (6) — Best (32), Second Best (35)

Second Year Matings

Pen 3 A Sire × Pen 32 A Dams — Pen 35 B Sire × Pen 6 B Dams

To Reproduce Strain A — To Reproduce Strain B

Strains A and B may be of the same or different breeds They need not be derived from closed flocks, in practice, the initial matings are rarely undertaken with closed flocks, which are not at present numerous But the strains must remain closed for all future matings, because reciprocal recurrent selection is a progeny test of selected strains

Reciprocal recurrent selection may be applied on a comparatively modest scale A breeder with two superior strains

The improvement will also depend on the selection pressure i e, the difference between hen housed average egg production of the flock and that of the birds selected for breeding

For example, if the flock shows a hen housed average of 200 eggs and the average production of the birds selected for breeding is 220 eggs the selection pressure is twenty eggs Five per cent thus represents an expected gain of one egg In other words, by applying a selection pressure of twenty eggs the progeny may be expected to average one egg per bird more than the progeny of unselected flock, assuming, of course, that the same sire was used in each case and the same environmental conditions prevailed for the progeny

Lerner found that selection on the basis of egg records to end of May is over 90 per cent as efficient as the complete record of the survivors

Progeny-tested Sires A system of breeding employing progeny-tested sires has been carried out for many years at the School of Agriculture, Cheshire

On account of the high mortality experienced in the early 'thirties, which was, of course, common to the country, methods at this centre were altered So far as breeding was concerned, it was decided to maintain the flock with stock bred from mature birds only, and to use progeny tested males Hatching eggs are purchased from recorded flocks, and the best of the resultant cockerels are mated with groups of pullets selected from the progeny of the foundation hens Some of these pullets are retained for breeding in their second season, but the daughters produced in their first season—i e, pullet bred pullets—are kept only for the purpose of progeny testing the sires After the first season they are sold

By this system the replacement stock are always sired by a tested male The method involves mating two year old sires

In addition to selecting birds on their own and their sisters' records, progeny-tested hens are also used. This method could be applied to second-season hens only, but, since they would not produce so many offspring, there would not be the same scope for selection.

At a meeting in London in 1948 Lerner pointed out that the University flock was founded by lines supplied by commercial breeders, and that since 1941 no new blood had been introduced.

The production index includes those factors with which the commercial man is mainly concerned—*i.e.*, egg production, livability, rate of maturity and so forth.

Many breeders are opposed to this method of selection, because, as practised at the University of California, it does not take into account body size, colour and other characters. It disregards the breed standards. But, as Lerner stated, if these characters were considered, the intensity of selection would be weakened. The smaller the number of characters for which the breeder selects, the greater the intensity of selection, and the greater the improvement that may be expected from year to year in those characters.

To what extent breed standards should be taken into account depends entirely on the requirements of the market for which the breeder is catering. If his customers are interested purely in egg production, if they want a high hen-housed output, then the breeder should select for it. If, however, his customers are concerned also with breed type, the breeder must select for it, in addition to egg production.

There is also criticism of the system in this country on the ground that it involves pullet-breeding season after season, and therefore may result in high mortality. But by this system it is impossible to have a high production index and high mortality, and breeding only from older stock does not automatically ensure low mortality. If the system were applied to hens only, the rate of improvement would necessarily be slower.

In the course of their studies with the University flock Lerner and his colleagues estimated that the production index (hen-housed average) has a low heritability (about 5 per cent); viability is inherited to a similarly low degree, while the heritability of the egg production of survivors may exceed 30 per cent. The heritability of egg size appears to be high as does meat

test the value of each mating For this reason culling should not be carried out with the thoroughness that should be applied in the ordinary course of events, in fact, it would be advisable not to cull at all, since this would show the breeder the average value of all the daughters, which is precisely the information he seeks

Pen-recording of each group should be concerned with factors of economic importance as these are revealed by the performance of each pen

These factors are Average age at maturity, number of eggs produced per month, egg-weight and colour, food consumption per month, broodiness and mortality

Since each hen should produce eight or ten daughters, it follows that from each pen there should be sufficient daughters for eight breeding pens

The chicks should be reared in their respective pen groups, records being kept of mortality, rate of maturity and other data of importance to the breeder When mature, the daughters of each sire are housed separately, and recording on the lines indicated should begin

The group giving the best performance should be chosen for the future breeding pens and mated with the best of the cockerels from the same pen—*i e*, their half brothers These daughters and their half-brothers make up eight breeding pens for the following season, and again the best group from these pens are used for the breeding-pens a year later So the system continues

This is a system of in breeding—half-brothers and half-sisters—and occasionally full brothers and full sisters, but it is based on all the progeny from the best pen It would be extremely dangerous to select the best birds from all the pens and make up breeding-pens with them

It must be emphasized that the rate at which improvement can be effected in this way will depend on the quality of the original stock, the higher the quality the more difficult it will be to improve it

It will be wise to retain a considerable number of cockerels for selection for the breeding-pens

The Bossert System. The Bossert system is based on the four-pen cycle The flock is closed, and it is assumed that the

with second-season hens, but it has been found practicable to keep some of the birds for three or four seasons.

The primary purpose of applying this method of breeding was to help in reducing mortality. This was accomplished, since losses among Rhode Island Reds have been between 0 and 4 per cent in recent years and among Brown *Leghorns* between 2 and 4 per cent. In 1936 mortality was 44 per cent and 23 per cent respectively.

It must not be assumed, however, that the improvement in viability was due entirely to the use of progeny-tested sires. There are many factors associated with problems of this kind, and it is always speculative which contribute most to the reduction in mortality.

The value of tested sires is now widely recognized, but it would be wrong to suggest that mortality will be lowered merely by breeding from them.

Pen-progeny Testing. A system of progeny testing based on the performance of all the birds in the pen, not on that of individuals, was long advocated by Hagedoorn, the Dutch geneticist.

From the commercial standpoint this system has much to recommend it, because the tedious job of trap-nesting is unnecessary, and the temptation to breed from a few individuals of outstanding quality, constantly before breeders working on orthodox lines, is removed.

The object of pen-progeny testing, or the nucleus system as it is commonly called, is precisely the same as that of the pedigree-breeder dealing with individual records—namely, the production of the most profitable stock.

The pen system, however, is concerned with groups of birds or families, not individuals. Selection is based on the family or group, and for this reason the breeder is able to secure a clear picture of the real value of his stock while avoiding trap-nesting and the need for keeping a vast number of individual records. Very briefly the system is applied as follows:—

The breeding hens are selected in the usual way, and are divided between a number of pens, each headed by a male bird to be tested.

Hagedoorn suggested starting with eight pens. The daughters from these pens are housed separately, the object being to

far as to become of practical value to the great body of breeders is doubtful

However, breeders are constantly searching for new methods of raising egg production above that secured by systems at present in use Blood typing may be the means of reaching higher levels

Explained in the simplest terms, blood typing is the identification of certain blood antigens or blood types that are associated with desirable commercial traits, such as high egg production and high hatchability—traits of low heritability

Blood typing involves blood testing for these specific antigens with the object of identifying birds having the right combinations that will give a further boost to production Although it involves blood testing, it is in no way associated with disease, it is not concerned with the detection of carriers of bacillary white diarrhœa and allied diseases

Dominant White Strains. Dominant white strains are in considerable demand, principally for table-poultry production In recent years they have been much sought by broiler producers

Dominant white has been established in some strains of White Rocks, Jubilee Indian Game, and other breeds

It is unfortunate from the table-poultry producers' viewpoint that the White Leghorn is the only common and reliable source of this character Having created a dominant white strain by crossing with this breed, the breeder must then effect improvement in table qualities, and he must, of course, at all times have regard to egg production

Dominance can be secured in two ways as follows —

A White Leghorn males are crossed with a coloured breed or a white breed carrying the factor for colour, *i e*, a non-dominant white

The progeny (F1) should then be back crossed to White Leghorn, when the (F2) generation will comprise approximately equal number of homozygous and heterozygous birds having the dominant white factor

Only homozygous individuals are required, and they can be identified by mating the F2 generation with a coloured breed Birds that produce only white progeny are dominant white

birds in each of the four pens are vigorous and unrelated. Each pen is mated with a selected sire, and each pen or group will ultimately consist of pullets, yearlings and two-year-old hens, and each pen is completed with a one-year-old cockerel unrelated to any of the females. To avoid confusion between female birds, those from pen 1 are toe punched 1; those from pen 2, 2 and so on.

The females are fixtures in their different pens, but the cockerels are not. They are moved in rotation. Yearling and two-year-old hens of each pen are mated with a cockerel, or more than one if necessary. Pullets are not used for breeding.

The cockerel (or cockerels) bred in pen 2 is used in pen 1, the one bred in pen 3 is used in pen 2, and so on.

The next season a cockerel bred in pen 3 is used in pen 1, the cockerel bred in pen 4 is mated to pen 2, and so on. The cockerels mated in pen 1 during the first three years are bred from pens 2, 3 and 4 respectively, when the order is reversed. Thus the rotation is 2–3–4—4, 3, 2. It is spread over six years, and is then repeated.

The figures 2, 3, 4 refer to the pens from which cockerels are drawn to mate with pen 1. The same principle is applied to other pens.

Close in-breeding is avoided, but of course the success of the system depends on having vigorous foundation stock above average quality. To start with stock of inferior quality would be disastrous, because the system is a form of in-breeding, and therefore cannot produce qualities the original stock does not possess.

Bossert recommends trap-nesting to ensure breeding from the best birds on the female side. Careful selection should be practised.

All cockerels are discarded at the end of their first season.

Blood Typing. Latest method aimed at securing successful gene combinations is that known as blood typing. The work is highly complicated and requires the service of a technician.

Blood typing is being applied by certain large-scale breeders in this country and in the United States, but it is beyond the scope of the average breeder. It is a new approach to the complex problem of selection for the improvement of stock already of superior quality. Whether it will be developed so

far as to become of practical value to the great body of breeders is doubtful.

However, breeders are constantly searching for new methods of raising egg production above that secured by systems at present in use. Blood typing may be the means of reaching higher levels.

Explained in the simplest terms, blood typing is the identification of certain blood antigens or blood types that are associated with desirable commercial traits, such as high egg production and high hatchability—traits of low heritability.

Blood typing involves blood testing for these specific antigens with the object of identifying birds having the right combinations that will give a further boost to production. Although it involves blood testing, it is in no way associated with disease; it is not concerned with the detection of carriers of bacillary white diarrhœa and allied diseases.

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A. White Leghorn males are crossed with a coloured breed or a white breed carrying the factor for colour, *i.e.*, a non-dominant white.

The progeny (*F1*) should then be back crossed to White Leghorn, when the (F2) generation will comprise approximately equal number of homozygous and heterozygous birds having the dominant white factor.

Only homozygous individuals are required, and they can be identified by mating the F2 generation with a coloured breed. Birds that produce only white progeny are dominant white.

This method results in a cross having 75 per cent White Leghorn blood.

B. A first cross is made with White Leghorn. The F1 progeny which will be white or predominantly so, should then be mated together, when they will produce white and black chicks and others of differing shades of grey.

All the black and grey chicks should be discarded.

Among the predominantly *white* chicks of this, the F2 generation, only about one-third will be homozygous for dominant white, the other two-thirds will be heterozygous and will usually, though not invariably, have a little black ticking in the down.

Chicks that are apparently pure white should be kept until they get their adult plumage, when it should be possible to identify homozygous individuals.

But some entirely white birds may not be homozygous for dominant white. All white birds of this generation should be tested for purity by crossing with a coloured breed.

Whichever method is employed in the production of dominant white strains, it is advisable to make-up a number of pens, to progeny test and to avoid close in-breeding.

Breeding from Pullets. Breeding from pullets has long been a controversial matter among poultry-breeders. Many condemn it without qualification. They point out that when breeding from pullets we are breeding from birds that have yet to prove their ability to live and lay. Some breeders even assert that if only two- and three-year-old birds were used for breeding purposes the problem of mortality would be resolved.

It is not quite so simple. When losses among adult birds became serious a large number of breeders used only their older birds, but mortality continued to take its heavy toll.

It is evident that if the problem could be solved in this way there would in fact be no problem.

Moreover, the breeders who regard breeding from pullets as unsound practice, on the ground that the birds are of unknown quality as far as egg production and livability are concerned, apparently have no objection to breeding from cockerels of equally unknown quality. It is illogical to suggest

that breeding from *pullets* is unwise, while breeding from cockerels is a commonly accepted practice

Experiments have shown that the mortality among the progeny of pullets that survive their first laying year is no greater than that among the progeny of hens

Uncontrolled breeding from pullets is undoubtedly unwise It means that the progeny of birds that die in their first year may be used for breeding purposes The tendency would be to propagate a strain having low livability

Breeding from selected pullets under control, so that the progeny of birds that die can be discarded, is an entirely different proposition, and one that no breeder need hesitate to adopt

Indeed, on the pedigree farm breeding from pullets is desirable, because it enables the breeder to obtain information regarding the breeding worth of the birds before they take their place in the breeding-pens in their second year

Breeding from pullets for this purpose, therefore, saves a year, and consequently effects a major economy

If pullets are not bred from, information regarding their worth as breeders cannot be obtained until after their second season In other words, they are still untested stock from the breeder's standpoint when mated in the second year

Further, fully matured, well grown pullets are in their prime for breeding purposes

Greenwood (1932) presented the following data showing the value of the progeny in relation to age of dam —

TABLE 15

Age in years	Hatchability, per cent	Infertile, per cent	Dead in shell per cent
7	15	46	39
4	24	34	42
3	60	5	35
2	69	6	25
1	69	7	24

It will be seen that there is marked deterioration in breeding value after the third year Only birds of outstanding quality justify their retention beyond that age

Hutt (1952) presented the following data from the Cornell University flock:—

TABLE 16

	Strain.	Hens		Pullets.	
		Fertile eggs	Hatched, per cent.	Fertile eggs	Hatched, per cent
1949 . .	K	1,138	87	2,700	89
1949 . .	C	832	81	1,057	82
1950 .	K	1,148	86	2,256	87
1950 . .	C	948	72	1,781	76
1951 . .	C	1,410	83	3,323	75

Hutt comments: "In the fifth comparison, the record for the pullets looks unfavourable, but that resulted chiefly from the fact that 5 of the 36 cockerels tested gave us hatches below 60 per cent. There were 16 for which hatchability was over 80 per cent.

"The good showing of the pullets in the figures given is all the more significant because they were a less-selected group than the old hens. Many of the latter had been used for breeding a year earlier, as pullets, and none were re-used again in the proven-sire matings unless their first year hatchability had been high. Among the pullet breeders no such selection was possible.

"All in all, it is clear that *pullets reproduce just as well as hens, or better.*

"So far as viability is concerned, the slight risk in using pullets as breeders can be offset in pedigree stock by selection for viability."

Hays (1955), from data over a five-year period on pedigree Rhode Island Reds bred for high fecundity, found that the age of the parents had no significant effect on the viability of the progeny either during the growing stage or of pullets in the laying house.

There was a highly significant difference between sires in the viability of their daughters in the laying house.

"In these birds selectively bred for high fecundity as the major consideration, *longevity was no criterion of viability of* the offspring."

The above facts provide the best answer to the question of pullet-breeding Of course if the breeding stock has a deficient diet, hatching-egg quality would deteriorate during a period of production

There can be no valid objection to breeding from pullets provided the birds are carefully selected and breeding is under control Indiscriminate breeding from pullets is likely to have disastrous consequences if continued year after year, but this also applies to indiscriminate breeding whatever the age of the stock

Methods of Mating. *Mass or Flock Mating* The term "mass" or "flock" mating means mating a number of males with a flock in the same pen It is a convenient method of providing a large number of fertile eggs, and is frequently adopted by commercial breeders The birds are not usually trap nested No pedigree work can be undertaken, because even if the birds are trapped the male parentage of the chicks is unknown

The number of males naturally varies with the size of the flock With 100 females it is usual to mate six or seven males

The males should have been reared together since it is essential that they be friendly Even so, mass mating should not be attempted in small runs Free range or at least a large run is most suitable for the purpose If mass mating is practised in a restricted area, screens of some kind should be erected to ensure a measure of privacy and so reduce interference during the act of mating

The need for privacy may seem exaggerated in view of the practice of breeding from large flocks kept intensively on deep litter, but in the average deep litter house food troughs and other equipment are of assistance in this respect, moreover, density of population itself provides some assurance against interference

Flock mating is the most common method of mating commercial flocks and, contrary to the belief of many breeders, "it is the best method of breeding for highly heritable characters like egg weight, body size, and growth rate Strains of chickens which grow most rapidly, have largest egg weight, most uniform colour and shell texture and the highest hatchability in the U S A were produced from flock matings, no pedigree and no family records"—Jaap (1951)

Jaap pointed out that the key to success in flock mating for such characters is a high "selection differential"—that is to say, the birds selected for parents should be high above the average of the flock from which they are selected.

Without using the trap-nest the breeder could assess the value of his birds by adopting a system of ringing (see p. 154), and if he mated his best hens to pedigree sires he would quickly improve a flock of average quality.

Pen-mating. Pen-mating means the mating of one male with a number of females. From eight to twenty-five females may be so mated, depending on the breed, conditions under which the birds are kept and the purpose of the breeder.

In common practice it is usual to mate from ten to fifteen females with one male, but, as previously mentioned, a virile male on range or in a large pen will give high fertility with a greater number of hens.

This system is most commonly adopted by pedigree-breeders because it ensures complete control and enables progeny-testing to be carried out. When the hens are trap-nested, the parentage of every chick can be easily traced.

Stud-mating. Stud-mating, or single penning, as it is sometimes called, refers to the mating of individual females, the male being introduced usually after the hen has laid.

Fronda showed that one mating per week is sufficient to secure good fertility, although two matings are advisable.

This system necessitates single penning of the females, or they may run with the male immediately after they have laid. Stud-mating is costly, since it involves much time and labour. It is not a practical method for commercial purposes.

On this system the male may be mated with a large number of females, provided the bird is vigorous and kept in breeding condition. The male must be well fed.

Alternate Mating. Occasionally a bird may be found that will not mate freely with certain hens. In other words, a female may give good fertility when mated with one male, but not with another.

This fact has been observed by a number of investigators. If therefore an individual female fails to give good fertility, she should be mated with another male before she is rejected for breeding purposes on account of infertility.

Alternating the male birds overcomes this difficulty and, moreover, tends to raise the general level of fertility. Some breeders mate two males with the same pen on alternate days, keeping the male not in use in a small pen by himself. Others use, say, six males for six individual pens, moving them from one pen to another every day or every few days.

This method usually improves fertility, but of course it cannot be applied on the pedigree farm.

Photos D J G Black

FIG. 65—(*Left*) COLLECTION OF SEMEN IN WAX-COVERED FUNNEL. (*Right*) INJECTION OF SEMEN WITH A SYRINGE INTO THE OVIDUCT. "RINGERS" SOLUTION MAY BE USED FOR DILUTION OF SEMEN

Artificial Insemination. Artificial insemination in poultry has been carried out successfully for some years, but its commercial possibilities have arisen only during the past three or four. It should be remembered that it is not a " cure-all " for infertility, but may be a very useful tool in tracking down the source of infertility in flocks.

Its economic value lies primarily in the breeding of turkeys of the broad-breasted type, in which physical disability results in a low degree of fertility. In turkeys A.I. can definitely improve fertility, but in so far as chickens are concerned, it will not increase the degree of fertility over that of natural matings during the normal breeding season. However, it will maintain high fertility in the late season (Cooper, 1955).

While the technique is not difficult to learn, considerable

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While the technique is not difficult to learn, considerable

practice is needed to become proficient. The basic technique developed by Burrows and Quinn (1937) is that in which the bird is held by the legs, breast resting on the operator's knee. The back is stroked several times rapidly, starting behind the wings, and moving towards the tail. The tail is then pushed back and the copulatory organ is exerted, the thumb and index finger grip behind the vent and keep the organ protruding.

By this pressure the semen is "milked" from the bulbous ducts into a wax lined funnel or by the apparatus described by Cooper (1955)—the advantage of this apparatus being that contamination by dust, fæces or excess water is avoided and that accurate amounts of semen may be collected.

It is only necessary to isolate males for a day or so before collection, but for regular use it is recommended that males be "milked" three times weekly on alternate days for optimal volumes.

The average volume of semen per collection varies between breeds, and the individual differences between cocks within breeds is extremely high. Volumes from Rhode Island Red and Barred Rock average almost 0.7 ml. While from White Leghorn 0.4 ml. was obtained during the first season (Cooper, 1956). There is some seasonal decline in production.

Complete figures for second season males were not obtainable, but for the first six month period in the second year Barred Rock averaged 0.5 ml. per collection—a decrease of 25–30 per cent.

Males being kept for A.I. must be individually housed, otherwise fighting results. Individual cages with 7–8 sq. ft. floor space and 2 ft. 6 in. headroom are satisfactory for both light and heavy breeds.

Males must be mature (eight to nine months old) before being used regularly. They may be lighted for a 13–14 hour day for a fortnight or three weeks before the breeding season commences. Feeding a well balanced breeders' ration is sufficient to maintain semen production, no supplements being required.

Hens require insemination once weekly with 0.1 ml. undiluted semen to maintain fertility of 80–83 per cent, but twice weekly inseminations with 0.05 ml. give 90–93 per cent fertility. After the first insemination eggs will be fertile on the second day

Graduation marks are inscribed on the cannula with a diamond pencil to enable the proper dose to be delivered.

Eversion of Oviduct. Birds are held facing the operator, who has his right hand on the abdomen and his left hand grasping the tail so that the wrist is lying along the back.

By applying sudden pressure with both hands the oviduct is everted outside the vent.

Delivery of Semen. The cannula is inserted into the oviduct as far as the rubber tubing.

By moving the cannula it is found possible to insert the tip of the cannula into the orifice of the utero-vaginal junction, and application of pressure on the plunger causes the semen to be deposited into the lower end of the uterus.

Perhaps the greatest limiting factor in the commercial use of A.I. is that of dilution and storage of semen. Present recommendations are that semen be used within one hour of collection. Research is being carried out in this country by the Poultry Research Centre, Edinburgh, and the Houghton Poultry Research Station, Huntingdon, on various aspects of fowl semen and artifical insemination.

Chapter Eight

Incubation

Development of the Chick. It is a remarkable phenomenon of Nature that under suitable conditions the viscous contents of the egg are transformed into the chick within so short a period as three weeks (hens' eggs)

Not only is this physical change effected, but in the cell from which the chick develops are carried all the hereditary factors that determine body-shape, colour of plumage, sex, fecundity, disposition and so forth

The science of embryology is very complex It has attracted the attention of a large number of investigators the world over Much knowledge has been acquired, but the closest study has so far failed to reveal all Nature's secrets

It is unnecessary for the poultry-man to study literature that discusses the subject in detail Nevertheless, he must understand the fundamental principles of incubation if he is to secure satisfactory results and grapple with the problems likely to arise in the course of his work

For practical purposes the egg is composed of five distinct parts They are (1) the shell, (2) the membranes lining it, (3) the white or albumen, (4) the chalazæ, (5) the yolk

(1) The shell, largely composed of calcium carbonate, forms the protective covering On the surface is the cuticle which gives protection from harmful micro-organisms, but not completely so, because certain organisms are capable of penetrating not only the cuticle, but also the shell

The shell is porous, permitting the passage of air and moisture, which play a vital part in the development of the chick It consists of a dense outer layer and a more granular inner layer

(2) Lining the shell are two thin membranes, which are also porous At one end of the egg the membranes separate to form the air space constituting a reservoir for respiratory gases

(3) The white consists of an outer layer of thin albumen, a

dense central layer of thick white, which contains an inner complement of thin white. The white is a reserve of food on which the embryo draws in the course of incubation. It also gives protection against shocks due to jarring.

(4) The chalazæ are coils of dense albumen on opposite sides of the yolk. They act as buffers, and are thus a further protection from shock. They are *not* attached to the shell mem-

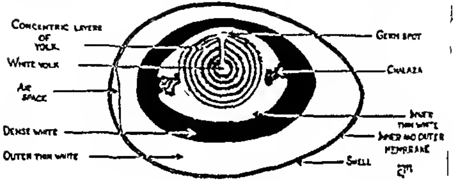

FIG. 66—STRUCTURE OF THE EGG (diagrammatic)

Composition of the egg

Shell	12%
White	55%
Yolk	33%

	White	Yolk	Complete egg
Moisture, %	87·2	53·1	65
Protein, %	11·5	14·4	11
Mineral matter, %	0·6	2·0	1 (excluding shell)
Fat and lecithin, %	0·1	29·3	10
Undetermined, %	0·6	1·2	1
Shell, %	—	—	12

branes, supporting the yolk in the manner of a hammock, as occasionally depicted.

The chalazæ are sometimes referred to as the "tread". This term is misleading. It implies that they are contributed by the male bird, whereas they are an integral part of the egg, and in no way associated with the male.

(5) The yolk is the ovum proper—that is, the only part of the egg that is the product of the ovary. It is contained in a thin skin known as the vitelline membrane.

The yolk is composed of dense oily material of high nutritional value. It is rich in proteins, fat, mineral matter and vitamins,

and with the white furnishes nourishment for the embryo, but, unlike the white, it also nourishes the chick for a short period after it has hatched.

The yolk is of two kinds, yellow and white, arranged in a series of concentric layers surrounding the central mass of white yolk. The yellow and white layers of yolk are not always clearly defined, for the yellow depends on the amount of xanthophyll pigment in the feed. Given a normal diet, it seems that the yellow layers are formed when feed containing pigment is being assimilated, and the white—or, more correctly, the paler—layers when it is not. It has been suggested that white yolk is formed in the early hours of the morning, when metabolism is low, and the yellow yolk during the day.

The central mass of white yolk is flask-shaped and the upper part forms the whitish spot on the surface of the yolk. This spot is referred to as the germinal disc or germ-spot in an infertile egg, but when the egg is fertilized it is known as the blastoderm. The presence of the germ-spot does not indicate whether or not an egg is fertile. All eggs contain this spot, but it is possible to distinguish between a fertile and an infertile egg by close examination.

In the fertile egg the blastoderm has an opaque rim, the "area opaca", surrounding a clear space, the "area pellucida". In the centre of the latter is a whitish spot formed by the upper neck of the flask-shaped central part of the yolk.

In an infertile egg the germ-spot is more or less of uniform whitisb colour over its entire surface, or there may be irregular clear spaces in it. It has not, however, the well-defined clear and opaque areas of the fertile egg.

This distinction cannot be made unless the egg is broken and the yolk closely examined. It is therefore of no value in the selection of eggs for incubation.

When a mature yolk leaves the ovary of a bird that is mated, one of the male sperms in the semen that lies in the upper part of the oviduct enters the yolk at the blastoderm, and thus fertilization takes place.

When this has been effected the single fertilized cell formed by the union of the male and female cells begins to develop by a process of splitting or segmentation; the single cell splits into two, the two iuto four and so on. This continues during the

passage of the egg along the oviduct until it is laid and cools below the physiological minimum temperature. Further growth is prevented provided the temperature remains below this level. The extent to which development has taken place at the time the egg is laid depends on the interval between fertilization and cooling.

Photo: [illegible], London

FIG. 67.—CHICK EMBRYO AFTER THIRTY-SIX HOURS' INCUBATION

For many years the physiological minimum temperature was considered to be about 68° F., but according to Funk and Biellier, cited by Romanoff (1938), "growth as indicated by enlargement of the blastoderm does not take place below 27° C." (approx. 80·6° F.).

When a fertile egg is placed under favourable conditions, as in incubation, development is resumed.

The blastoderm consists of three layers: the top (or ectoderm), the bottom (or entoderm) and the central layer (or mesoderm). It is in these three layers that the early development of the embryo takes place, and they may be described as the foundation on which the chick is built stage by stage. These three layers are characteristic of the embryonic development

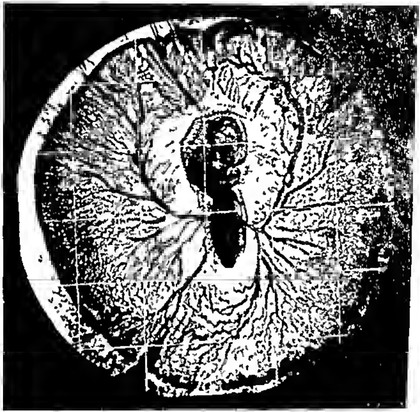

Photo Spratt's Patent Ltd, London

FIG. 68.—CHICK EMBRYO AFTER SEVENTY-TWO HOURS' INCUBATION

of animals, and in fact the growth of the chick embryo follows the same general course as in mammals. Life begins with the single cell. The early development of the embryo takes place in the area pellucida, and can be observed on the first day of incubation. It is known as the "primitive streak".

In the course of incubation the blastoderm gradually extends in area, and by a complex process of folding two membranes are formed—the inner called the amnion and the outer the

passage of the egg along the oviduct until it is laid and cools below the physiological minimum temperature. Further growth is prevented provided the temperature remains below this level. The extent to which development has taken place at the time the egg is laid depends on the interval between fertilization and cooling.

Photo: Spratt's Patent Ltd., London

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For many years the physiological minimum temperature was considered to be about 68° F., but according to Funk and Biellier, cited by Romanoff (1948), "growth as indicated by enlargement of the blastoderm does not take place below 27° C." (approx. 80.6° F.).

When a fertile egg is placed under favourable conditions, as in incubation, development is resumed

After ninety-six hours' incubation the embryo can be clearly seen, and if it is carefully removed from the surrounding matter it will be noted that it is connected with the yolk by a short tube. This is the umbilical vessel or navel cord, and corresponds in position and function with that of mammals. It is through this tube that nourishment is conveyed from the yolk and white to the embryo.

If the embryo is removed from the egg, say after five or six days' incubation, its appearance is quite unlike that of a

Photo Spratt's Patent Ltd., London

FIG. 70 —EGG AFTER SIX DAYS' INCUBATION, AS SEEN BEFORE THE TESTING LAMP

chicken, but resembles some creature that, if seen enlarged, would be regarded as a monster of abnormal proportions. At this stage it has two enormous staring eyes with bright, translucent pupils, a large head and a comparatively small body. If examined after six days, rudimentary legs and wings can be seen, but it is not until the eighth day that feather-tracts can be observed along the back. On the ninth day the beak is distinguishable as a short, blunt snout. On the twelfth day it will be seen that the eyelids are beginning to form, and on the thirteenth day down covers the body. On the fourteenth day the down is obvious and the beak begins to take the shape more familiar to us.

During the second week of incubation the embryo becomes

chorion—which envelop the embryo. The amnion contains the amniotic fluid.

At a later stage another membrane is formed. This is called the allantois—a part of the alimentary system which grows from the embryo, spreads over its body and later becomes fully charged with blood-vessels that are readily seen after

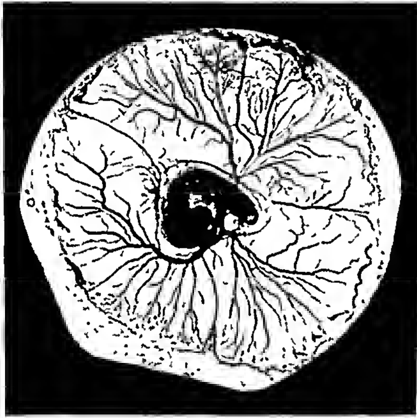

Photo: Spratt's Patent Ltd., London

FIG 69—CHICK EMBRYO AFTER FOUR DAYS' INCUBATION

a few days of incubation if the egg is held before a strong light, a practice known as "candling".

As incubation proceeds the allantois makes close contact with the chorion which lies against the shell membranes, and becomes the chick's respiratory organ. It fulfils the purpose of the lungs, enabling "aquatic respiration" to be carried on. In addition, the allantois absorbs albumen and transfers it to the embryo; and deals with excretory products of the embryonic kidneys.

Skoglund and Brown (1956) studied the effect of frequency of collection on hatchability at the University of New Hampshire. Eggs were collected at eight, eleven, one and four o'clock to provide the alternatives of collecting one, two, three or four times daily.

During the experimental period from autumn 1951 to summer 1953 average daily temperature varied from a minimum of 16.7° F. to a maximum of 88.8° F.

Results were inconsistent in relation to frequency of collection, and in no case were the differences significant. It was concluded that frequency of collection is not important as far as hatchability is concerned.

Broody hens should be removed from the nests immediately they are detected. If they are not segregated they may cause lower hatchability by promoting the growth of the embryo to a relatively advanced stage before it is arrested by storage conditions.

Ample nest accommodation should be provided, and the nests should be well littered with clean straw or wood shavings, or plastic nest pads can be used.

Eggs should be collected in a wire or plastic basket, permitting free circulation of air to ensure rapid cooling.

Selection and Storage of Hatching Eggs. Eggs intended for incubation should be selected with care because any abnormality is likely to have an adverse effect on hatchability, and such abnormal eggs as hatch will probably yield weakly chicks.

Hatching eggs should weigh between 2 and 2¼ oz. Very large eggs—and by that is meant large for the family or strain of birds used for breeding purposes—do not hatch so well as those of average size. Small eggs are obviously undesirable.

It is essential to follow a middle course so far as egg size is concerned because large eggs contain a higher proportion of thick white than small eggs, and as the proportion of thick white increases so hatchability declines.

It also declines because as eggs increase in size, the contents increase as a cube and the shell as a square. Thus the rate of evaporation has to be more rapid as the pores of the egg shell do not increase sufficiently *pro rata*.

For table purposes a high proportion of thick white is desirable. It improves both the keeping and whipping

capable of independent movement, and slightly alters its position from time to time during the later stages.

By the sixteenth day the albumen is almost completely absorbed, the embryo relying mainly on the yolk for its nourishment.

On the seventeenth day the amniotic fluid begins to disappear, and on the nineteenth day the yolk is gradually drawn into the body through the navel. At this stage the chick forces its beak into the air-space and begins to use its lungs for the first time, although it is not until the shell is pipped that respiration is carried on entirely by the lungs.

Photo by the Author

FIG. 71.—CHICK EMBRYO AFTER NINE DAYS' INCUBATION

The air-space appears to be necessary before the chick breathes free atmospheric air. It constitutes an intermediate stage between aquatic and pulmonary respiration.

Before hatching, the chick's legs are drawn up close to the body, and the head is tucked under the right wing, with the beak against the air-space. That is the normal presentation.

Pecking the shell while changing its position, the chick ultimately breaks it, and when it is sufficiently broken pushes against the small end of the shell with its legs, and thus enters the outside world

Collection of Hatching Eggs. Very frequent collection of hatching eggs is unnecessary, since extreme temperatures are rarely experienced in this country. Even during exceptionally cold or hot weather collection three times daily will be adequate.

Candling will also show the defect known as mottling—i.e., when the egg is held before the lamp the shell is seen to have a mottled appearance, due to lightish areas. Holst, Almquist and Lorenze have shown that this appearance is due to an uneven distribution of moisture in the shell. The eggs behave normally when stored, but they do not hatch so well as those having perfect shells.

Regarding storage, it should be emphasized that eggs should not be kept longer than necessary. Experimental work has shown that eggs stored under suitable conditions for periods not exceeding five days show no perceptible difference in hatchability or quality of the chick. When stored for longer periods, however, it is estimated that hatchability and the quality of the chick deteriorate to the extent of approximately 4 per cent for every day an egg is kept after the fifth.

For practical purposes eggs may be kept for seven or eight days, but, however favourable the conditions of storage, the sooner they are incubated the better.

The optimum temperature for storage lies within the range of 50–55° F.

Funk (1934) found that chilling eggs at 32–38° F. for forty eight hours did not affect hatchability, and that it required seven days' holding in that temperature range to reduce hatchability to zero, although it decreased after ninety six hours.

Olsen and Haynes (1948) obtained the following results with eggs stored for six to eight days:—

TABLE 18

Effect of Storage Temperature on Hatchability

Storage temperature (°F.)	Percent hatch of total eggs	Percent hatch of fertile eggs
30	2 0	2 2
40	66 1	71 1
50	71 3	78 6
60	70 0	76 7
70	69 1	73 7

Olsen (1951) compared the effect of storing eggs less than twenty four hours old at 32° F. for three, four and five days prior to incubation with eggs stored for five days at 55° F. His tests showed that embryos from all varieties and crosses

quality. Eggs having much thick white are therefore preferred for cooking.

Thus high hatchability and superior cooking quality are incompatible.

The shell should be strong and perfectly sound, *i.e.*, free from small cracks known as hair cracks.

In no circumstances should *eggs having thin shells* be incubated. Apart from the possibility of the defect being transmitted, thin shells prevent the normal interchange of gases—*i.e.*, the absorption of oxygen and the expulsion of carbon dioxide necessary for the respiratory process of the growing embryo. Almost certainly a thin-shelled egg, if it hatches, will produce a weakly chick.

Further argument against using thin-shelled eggs is that the embryo draws on shell calcium for its needs during incubation.

By candling hatching eggs prior to incubation those having defects known to reduce hatchability may be removed but few consider this work worth while.

Olsen and Haynes (1949) examined 47,950 new-laid White Leghorn eggs. Of these, 1,894, or about 4 per cent, showed one of the defects mentioned in the following table, which shows the percentage of infertility and hatchability of the defective eggs:

TABLE 17

Egg Characteristics which Influence Hatchability

Type of defective eggs	No. of eggs set.[1]	Percentage of eggs infertile.	Number of chicks hatched.	Percentage hatch.	
				Fertile eggs set.	Total eggs set.
Cracked eggs	610	25.4	232	53.2	39.7
Extra large eggs (65 gr. or more)	332	34.0	155	70.8	46.7
Small eggs (45 gr. or less)	155	51.6	60	80.0	38.7
Misshapen eggs	68	30.9	23	48.9	33.8
Poor shells	102	27.5	35	47.3	34.3
Loose air cells	47	27.7	11	32.4	23.4
Misplaced air cells	406	21.9	216	68.1	53.2
Large blood spots	124	21.3	68	71.5	55.3
All defective eggs	1894	28.3	840	61.8	44.4
Control eggs	3031	17.7	2174	87.2	71.7

[1] The first column of figures gives the numbers of eggs of various types found among 47,950 newly-laid White Leghorn eggs.

Candling will also show the defect known as mottling—, when the egg is held before the lamp the shell is seen to have a mottled appearance, due to lightish areas. Holst, Almquist and Lorenze have shown that this appearance is due to an [illegible] distribution of moisture in the shell. The eggs behave normally when stored, but they do not hatch so well as those having perfect shells.

Regarding storage, it should be emphasized that eggs should not be kept longer than necessary. Experimental work has shown that eggs stored under suitable conditions for periods not exceeding five days show no perceptible difference in hatchability or quality of the chick. When stored for longer periods, however, it is estimated that hatchability and the quality of the chick deteriorate to the extent of approximately 4 per cent for every day an egg is kept after the fifth.

For practical purposes eggs may be kept for seven or eight days; but, however favourable the conditions of storage, the sooner they are incubated the better.

The optimum temperature for storage lies within the range of 50–55° F.

Funk (1934) found that chilling eggs at 32–38° F. for forty-eight hours did not affect hatchability, and that it required seven days' holding in that temperature range to reduce hatchability to zero, although it decreased after ninety-six hours.

Olsen and Haynes (1948) obtained the following results with eggs stored for six to eight days:—

TABLE 18

Effect of Storage Temperature on Hatchability

Storage temperature (°F).	Percent hatch of total eggs	Percent hatch of fertile eggs
30	2.0	2.2
40	66.1	71.1
50	71.3	78.6
60	70.0	76.7
70	69.1	73.7

Olsen (1951) compared the effect of storing eggs less than twenty-four hours old at 32° F. for three, four and five days prior to incubation with eggs stored for five days at 55° F. His tests showed that embryos from all varieties and crosses

tested were affected adversely as a result of storage at 32° F. In every case mortality was greatest among embryos subjected to 32° F. for the longest time. There was considerable variation in the degree of resistance to low temperature among different varieties and crosses.

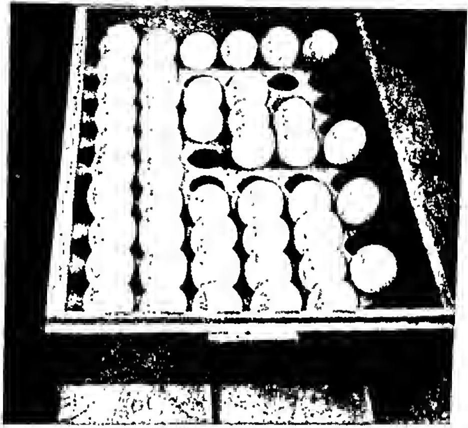

Photo: Modern Poultry Keeping

FIG. 72.—THE DRAWER OF AN EGG-STORAGE CABINET

On the pedigree farm each row of holes may be allotted to the eggs of individual birds.

High storage temperature will cause hatchability to decline rapidly. It should not exceed 65° F. even for short periods.

Hatching-eggs should not be exposed to draughts, because these tend to accelerate the rate of evaporation and so reduce the permeability of the shell membranes. Relative humidity of the storage room should be high—75-80 per cent is desirable. This will conserve the moisture in the eggs.

Eggs should be stored with the broad end upward, or on their sides, never with the broad end down

Finally, if eggs are not kept more than a week it is quite unnecessary to turn them If held for a longer period they should be turned

Only clean eggs should be used for incubation Slightly soiled ones may be cleaned by one of the following methods without affecting hatchability —

Egg-washing machine with warm water
A 2 per cent solution of sodium hydroxide
A 0 5 per cent solution of formalin

It is recommended that soiled eggs be placed in a wire basket, immersed in the solution at a temperature of 80 90° F and rotated several times They should not be washed prior to immersion Any dirt remaining on the eggs after this treatment should be removed with cotton-wool dipped in the solution

After dipping eggs should be set aside for a few hours to dry before setting

But egg cleaning is tedious work Steps should be taken to prevent eggs becoming soiled by attention to nest and house litter and the ground about the houses

Further reference to the disinfection of hatching eggs will be found in Chapter Twenty.

Pre-incubation of Hatching Eggs. Olsen (1949) has shown that it is entirely feasible to incubate eggs for eighteen hours, then to test them for fertility, and ship pre incubated eggs distances occupying up to ninety-six hours' travel without reducing hatchability

Pre-incubated fertile eggs in transit from fifty to ninety-six hours gave hatchability of 78 4, 78 3 and 80 5 per cent respectively, un-incubated eggs shipped in the same cases gave hatchabilities of 70 3, 79 7 and 76 3 per cent respectively

To test further the resistance of eighteen hour embryos to adverse conditions, groups of pre-incubated fertile eggs were stored for seventy-two hours at 55° F Un-incubated eggs served as controls and were stored at 55° F for three and three-quarter days The experimental and control eggs were then

incubated. The pre-incubated eggs gave an average hatchability of 82·7 per cent, as compared with 81·6 per cent for the controls.

When testing eggs at this stage a 75-watt blue lamp should be used or a daylight lamp. With the latter the tester should wear blue glasses.

The writer is not aware of any farm or hatchery adopting preincubation testing. The additional labour involved is not considered justified.

Artificial Incubation. Improvement in the design and construction of incubators, and more extensive knowledge of the requirements of hatching eggs, have made artificial incubation so reliable that machines have largely, and on most farms completely, replaced broody hens.

Artificial incubation is labour-saving; it enables chicks to be produced in quantity at any time of the year; a chick-production programme can be drawn up with the knowledge that its fulfilment is not dependent on a sufficient number of hens becoming broody at the right time.

Natural hatching has no place in the modern poultry industry.

Chinese and Egyptian Methods of Incubation. Artificial incubation of hens' eggs was practised by the Chinese and Egyptians for centuries before *Christ*, and the same methods are still employed by them.

Judged by our standards the methods are primitive. The Chinese use earthenware vessels with smaller vessels inside them. These latter are loaded with baskets of eggs as the collectors bring them to the hatchery. Heat is provided by charcoal fires in the bottom of the larger vessel. Each incubator has a capacity of some 600 eggs.

The Egyptians employ a different system. They adopt mass-production methods, using mammoth ovens holding thousands of eggs. The ovens are of permanent construction, being in fact part of the hatchery building. They are heated by fire, the fuel being camel-dung and straw.

Neither the Chinese nor the Egyptians use thermometers or capsules. They know instinctively the requirements of the hatching egg, the work having been handed down from father to son for generations. The hatcheries are largely family affairs.

Although the methods show no change with the passing of the centuries, recent inspection of hatching results from Egyptian earth incubators showed a 66 per cent average hatchability (Coles, 1958)

And these results are obtained from breeding flocks having diets far below the standards of the average breeders' diet fed in this and other countries in which the nutritive requirements of breeding stock have been extensively studied

In the Western world the first attempts to incubate eggs by artificial means met with little success In the eighteenth century the task was accomplished, but whatever success the inventors achieved, their methods were not generally adopted Early in the nineteenth century more progress was made, but incubators at that time did not seriously challenge the broody hen

Modern Methods In 1883 Hearson invented the capsule, which made possible thermostatic control of the temperature of the incubator The result of this invention was far reaching Progress in artificial methods was then rapid, and reliable machines were soon placed on the market

There is no doubt that Hearson's discovery was of outstanding importance It marked the beginning of a new era in poultry production, and laid the foundation on which a great industry was to be based

Successful incubation, however, does not depend on temperature alone Other factors are composition, humidity and rate of movement of air, and turning of the eggs All these factors have received considerable attention by scientific investigators in an endeavour to discover ideal conditions for incubation

Before discussing these physical factors, however, it is desirable to point out that the quality of the hatching eggs is of primary importance Many poultry men appear to overlook this point They regard the presence of unhatched eggs at the conclusion of the period of incubation as evidence that the machine is at fault or their methods incorrect in some essential detail

While it is necessary to consider all factors when results are unsatisfactory, it should be realized that the vigour and condition of the breeding stock, and the presence or absence of a

lethal factor in the egg, determine the percentage of chicks produced even where conditions of incubation are ideal

Hatchability (see p 162) is an inherited character There are some birds that give low hatchability, and it is obviously advisable to remove them from the breeding-pens early in the season If hatching eggs are marked with the dam's number it is usually found that the majority of those failing to hatch are laid by certain birds, assuming of course that conditions for incubation are satisfactory, the breeding-stock is in good condition and receives an adequate diet

Estimating Number of Chicks As previously stated, hatchability should not be less than 65 per cent of all eggs set or 85 per cent of fertile eggs, but in estimating chick production for the purpose of sales, it is usual to assume 60 per cent hatchability *Making the usual provision for a percentage of* unsaleable chicks, this is equivalent to 200 " as hatched " chicks or 100 pullet chicks per case of 360 hatching eggs

Allowing for an average loss of 10 per cent in rearing from day old to maturity, and assuming that 50 per cent of the chicks are males, on this basis about four eggs are required to produce a mature pullet

This is a fair average estimate for efficient husbandry, but, as may be expected, there is a wide difference between the results obtained on different farms Some breeders secure in the region of 80 per cent hatchability and have negligible losses in rearing, while others have low hatchability and high chick mortality They may average more than five eggs per pullet

Normally hatchability is lower during the winter months than *in* the *spring* On some deep litter plants average hatchability is about 80 per cent throughout the season, due to a more favourable environment in winter

Chapter Nine

Principles and Practice of Artificial Incubation

Ventilation. There are two critical periods in incubation—namely, about the fourth day and again on the eighteenth to nineteenth day. It is at these periods that the bulk of embryonic mortality occurs, although of course embryos may die at any time.

Payne (1919) found that 64·9 per cent of the mortality occurred between the fourth and sixth days and between the eighteenth and twenty-first days, by far the greater percentage (48·7) falling in the latter period.

Byerly (1930) obtained results in close agreement with those of Payne, except that he found mortality to be higher on the second and third day than on the fourth.

As mentioned in the preceding chapter, it is necessary to consider all factors affecting incubation when results are unsatisfactory. Many complaints arise from malnutrition of the breeding stock, from the presence of lethal genes, from faulty conditions of storage of the hatching eggs; nevertheless, whenever high mortality occurs during the later stages, the question of ventilation should be considered. The reason for this is that while the embryo can tolerate considerable concentration of carbon dioxide in the atmosphere while it is breathing aquatically, the moment it breaks into the air-space and begins to use its lungs it is very susceptible to carbon dioxide poisoning. This has been shown by experimental work by a number of independent investigators.

Weinmuller (1928), for example, carried out an experiment in which fresh air was excluded from a section of an incubator by closing all ventilators with paper. The papering produced such an air-tight condition (the egg tray was not removed at any time during incubation) that 74·5 per cent of the embryos, although fully developed, remained unhatched in their shells.

Reviewing this and other experiments designed to test the

lethal factor in the egg, determine the percentage of chicks produced even where conditions of incubation are ideal.

Hatchability (see p. 162) is an inherited character. There are some birds that give low hatchability, and it is obviously advisable to remove them from the breeding-pens early in the season. If hatching-eggs are marked with the dam's number it is usually found that the majority of those failing to hatch are laid by certain birds, assuming of course that conditions for incubation are satisfactory, the breeding-stock is in good condition and receives an adequate diet.

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Normally hatchability is lower during the winter months than in the spring. On some deep litter plants average hatchability is about 80 per cent throughout the season, due to a more favourable environment in winter.

tion, that of the fowl may vary between approximately 105° F and 109° F. It is usually at its minimum during rest and rises when the bird is active.

It is popularly supposed that the temperature of a broody hen is higher than normal, that the bird develops "broody fever". This is not in accordance with the facts. Actually, the temperature of the broody hen is subnormal usually to the extent of about 2° F., compared with that of an active bird.

The average temperature of the egg—at the centre of the egg during incubation—is a matter of great importance. Investigation has shown that the optimum temperature when the relative humidity of the atmosphere in the machine is 60 per cent is 100° F. This is the normal temperature at which forced-draught incubators are operated.

Townsley (1930) has shown that as the relative humidity is increased the temperature of the machine should be decreased, and that when the relative humidity is very low the temperature should be kept somewhat above normal.

In the sectional type of incubator—natural-draught machines—there is normally a wide difference between the temperature at the top of the egg and that at the bottom. Since the average temperature—*i.e.*, through the central plane of the egg—is the vital factor, it is usual to keep machines of this type at 103° F., the bulb of the thermometer being just clear of the top of the eggs. It should not actually touch them.

As the embryos develop they generate heat, and towards the end of the period of incubation this is considerable.

Consequently, in natural-draught machines there is a tendency for the temperature to rise as incubation proceeds, especially during the last few days.

In the course of his experiments Romanoff found that better results were obtained if the temperature was lowered somewhat instead of permitting it to rise. He recommends a reduction by ½° F. during the second week of incubation and by as much as 2° F. during the third week in natural-draught machines, and by ½° F. and 1½° F. respectively in forced-draught machines. The latter, however, usually contain eggs in different stages of incubation, so that it would not be possible to carry out this recommendation.

A matter of importance, which these experiments have

oxygen requirements of the embryo, he states, "Without doubt fresh air from about the twelfth day of incubation onwards is absolutely necessary for the further development of the embryos".

Romanoff (1933) states that each hen's egg consumes daily at the seventh day of incubation 0·071 gramme of oxygen, at the fourteenth day 0·714 gramme, and at hatching-time about 1·714 grammes, and eliminates daily at corresponding ages 0·05 gramme, 0·5 gramme and 1·2 grammes of carbon dioxide.

The progressive increase in the amount of ventilation required per 1,000 eggs is shown in the following table (after Romanoff):

TABLE 19

Gaseous Exchange in Development of Chick Embryo

(Per 1,000 eggs.)

Stages in incubation, days.	Absorption of oxygen, cubic feet.	Expulsion of carbon dioxide, cubic feet.
1	0·556	0·29
2	0·371	0·19
3	0·556	0·29
4	0·769	0·38
5	1·17	0·58
6	1·51	0·77
7	1·88	0·96
8	2·28	1·15
9	2·65	1·31
10	3·79	1·92
11	5·66	2·83
12	9·45	4·86
13	15·10	7·69
14	18·9	9·6
15	22·7	11·5
16	26·5	15·4
17	28·4	14·4
18	30·0	15·4
19	32·2	16·3
20	37·8	19·2
21	45·4	25·0
	288·0	146·0

It will be seen that adequate ventilation plays an indispensable part in incubation. The fertile egg is a living being. It cannot exist without fresh air.

Temperature for Incubation. It is perhaps appropriate to mention that the normal temperature of the hen is 105° F., but it varies very considerably, even among birds in good health. Whereas the temperature of man shows little varia-

A low temperature will prolong the period of incubation, otherwise the effect is similar to that of a high temperature, in that it results in abnormal development of the embryo

Sanctuary (1925) examined 1,490 embryos that had died about the eighteenth day, and found that over 50 per cent were malformed

Malformation may be inherited, but it is clear that it is also induced by conditions of incubation, and that the maintenance of the correct temperature will do much to reduce losses arising from this cause

Nutritional deficiency may also be responsible For example, a deficiency of riboflavin in the diet of breeding stock if sufficiently severe, will cause curled toes in chicks or clubbed down in full term embryos A deficiency of manganese may result in chicks having parrot beaks, shortened limbs and wiry down

Humidity In the course of incubation eggs lose weight owing to reduction in the water content The amount of loss varies proportionately with the humidity of the atmosphere in the incubator If the air is too dry, evaporation is excessive resulting in lower hatchability and small chicks On the contrary, if it is too moist, normal evaporation cannot take place This also results in lower hatchability, but chicks that hatch are larger than usual

In extreme cases evaporation of the egg contents is so restricted that the chicks are said to be drowned in their shells

Experiments at a number of centres have shown that to ensure the best results the relative humidity of the air in the incubator should be maintained at 60 per cent, about 70 per cent at hatching time Undoubtedly considerable latitude is permissible without affecting hatchability

Turning During incubation eggs should be turned at frequent and regular intervals to prevent the embryo adhering to the shell membrane and the allantois to the yolk

Turning is essential for the normal development of the embryo The sitting hen is constantly moving her eggs

For many years turning two or three times daily was considered adequate, but recent work has shown that more frequent turning, particularly during the early period of incubation,

revealed, is that if the temperature is not reduced in the course of incubation, at least it should be prevented from rising.

Romanoff (1936), in a paper read at Harper Adams Agricultural College Conference, gave the following table that might be accepted as a guide under average conditions:—

TABLE 20

Temperature and Humidity in Incubation

	1st Week	2nd Week.	3rd Week
NATURAL-DRAUGHT MACHINES			
Temperature . .	102½° F.	102° F.	100° F.
Humidity:—			
Relative . . .	60%	60%	60%
Wet Bulb	89½° F.	89° F.	87½° F.
FORCED-DRAUGHT MACHINES			
Temperature . . .	100° F.	99½° F.	98° F.
Humidity —			
Relative . . .	60%	60%	60%
Wet Bulb	87½° F.	87° F.	86° F.

But in this and other matters relating to incubator operation, makers' directions should be followed. Procedure should be modified only if experience shows that under conditions prevailing on individual farms it will effect improvement.

Variation in Temperature. While a variation of a degree or so for short periods in the temperature of the incubator is not a cause for anxiety, it is desirable to control the temperature within as narrow limits as possible.

Incubation can be speeded up to some extent by keeping the machine at a relatively high temperature; it can be delayed by too low a temperature, but since the object of incubation is to produce the maximum number of strong chicks, every endeavour should be made to maintain optimum conditions.

Too high a temperature not only accelerates rate of development, but it causes the production of abnormal embryos and lowers hatchability. Moreover, the chicks that hatch under these conditions lack vitality, and are therefore more difficult to rear.

Considerable variation in temperature may result in the production of chicks having crooked toes, twisted beaks, sprawling legs and so on.

A low temperature will prolong the period of incubation, otherwise the effect is similar to that of a high temperature, in that it results in abnormal development of the embryo

Sanctuary (1925) examined 1,490 embryos that had died about the eighteenth day, and found that over 50 per cent were malformed

Malformation may be inherited, but it is clear that it is also induced by conditions of incubation, and that the maintenance of the correct temperature will do much to reduce losses arising from this cause

Nutritional deficiency may also be responsible For example, a deficiency of riboflavin in the diet of breeding stock, if sufficiently severe, will cause curled toes in chicks or clubbed down in full term embryos A deficiency of manganese may result in chicks having parrot beaks, shortened limbs and wiry down

Humidity In the course of incubation eggs lose weight owing to reduction in the water content The amount of loss varies proportionately with the humidity of the atmosphere in the incubator If the air is too dry, evaporation is excessive, resulting in lower hatchability and small chicks On the contrary, if it is too moist normal evaporation cannot take place This also results in lower hatchability, but chicks that hatch are larger than usual

In extreme cases evaporation of the egg contents is so restricted that the chicks are said to be ' drowned in their shells

Experiments at a number of centres have shown that to ensure the best results the relative humidity of the air in the incubator should be maintained at 60 per cent about 70 per cent at hatching time Undoubtedly considerable latitude is permissible without affecting hatchability

Turning During incubation eggs should be turned at frequent and regular intervals to prevent the embryo adhering to the shell membrane and the allantois to the yolk

Turning is essential for the normal development of the embryo The sitting hen is constantly moving her eggs

For many years turning two or three times daily was considered adequate, but recent work has shown that more frequent turning, particularly during the early period of incubation,

improves hatchability. Turning should be in opposite directions, alternately. Turning in the same direction results in high mortality and broken yolks. In natural-draught machines not equipped with turning devices, however, turning two or three times daily must suffice, because any advantage obtained by more frequent turning would be countered by the harmful effect of excessive cooling which constant removal of the eggs from the incubator would involve. Moreover, the question of labour must be considered. Although many turn eggs twice daily, turning three times is preferable. It has the further advantage in that the eggs do not occupy the same position every night when the longest interval between turning occurs.

Turning should begin within about twelve hours of setting the eggs. It should be discontinued on the eighteenth day, although there is no apparent advantage in turning after the sixteenth day. This may appeal to operators of natural-draught machines on account of the saving of labour.

Cabinet incubators are equipped with manually or power-operated turning devices. With the former eggs should be turned four or preferably five times daily.

In incubators fitted with power-operated turning mechanism the interval between turnings can be adjusted. In many machines the eggs are turned every hour.

There is much to be said in favour of automatic turning. It saves labour, ensures regularity of turning, and the work is done slowly and gently without risk of injury to the embryos.

Housing the Incubator. From what has been said regarding incubation it will be apparent that suitable housing for the machines is of real importance.

The capsule of the incubator and the general mechanism for heat control are very efficient in modern machines, especially those of the forced-draught or mammoth type; but, even so, it is essential that the room temperature shall be reasonably constant. A variation of a few degrees is of no consequence, but rooms in which the temperature varies from, say, 40° F. to 70° F. must be regarded as unsuitable, and incubation should not be attempted in them. The ideal temperature for an incubator room is 60° F. for natural-draught, 70° F. for forced-draught machines.

Variable room temperature prevents the maintenance of

stable conditions in the machines It is not simply a matter of heat The problem is far more involved than that, because every change in temperature affects ventilation and humidity The greater the difference between room temperature and that of the machine, the greater the rate at which air passes through natural-draught machines Further, the lower the temperature the less moisture the air is capable of holding

It is not suggested that thermostatic control of room temperature is essential, although it is often employed by hatcheries and on the larger poultry-farms, and this is perhaps the best evidence of its value

Room-temperature control is fully justified, however, where incubation is carried out on an extensive scale In such circumstances the installation and running costs of hot water or electric radiators should be regarded as an investment Much of the cost of heating will be returned by saving in the cost of heating the machines In addition, taking the average for the season, more and better chicks will be produced because good conditions in the incubators can be assured

An incubator room built partly underground—to a depth of, say, 3 or 4 ft —may be regarded as ideal, subject of course to due provision for ventilation at or near floor level, but rooms built entirely above ground are satisfactory if efficiently insulated

The most suitable material for the floor is well-made concrete, with one or more drains, so that the floor may be hosed when necessary. Concrete floors should have a granolithic surface or they should be finished with one of the proprietary preparations that impart a hard surface and prevent dust

The ideal wall is of 11-in -cavity brick failing this, the next best is timber framing with 1-in T. and G (tongued and grooved) weatherboards outside, the interior being lined with one of the fibre boards commonly used by builders The space between boards and lining should be about 2 in , and if this is filled with paper, wood shavings or tightly packed cut straw insulation will be markedly improved

Glass wool is especially effective for this purpose It is available in loose form and as a quilt Many types of fibre-boards, plaster-boards and other materials of high insulation value are obtainable Further reference to them will be found in Chapter Nineteen

For the insulation of the roof there is nothing to equal thatch, but most people to-day use more modern, although not necessarily equally efficient, means of construction.

Where thatch is not used, a good roof may be made with 1-in. T. and G. boards covered with asbestos-cement tiles or roofing felt. The roof, in common with the walls (unless they are brick), should be lined.

A full-span roof is recommended because, apart from other advantages, it is much easier to provide efficient ventilation with this type than any other.

The roof lining should be attached to the rafters. If fitted horizontally, forming a flat ceiling, there should be an abundance of top air. Low ceilings are undesirable.

Ridge ventilation should be provided by cowl extractors. Ventilation at floor level and at ridge should be under control. Today fan extraction is becoming increasingly common. In some incubator rooms ventilation is entirely dependent on fans, while in others they are used from time to time to supplement natural-draught ventilation when owing to weather conditions the latter is inadequate.

A 12-in.-diameter fan running at normal speed extracts about 40,000 cu. ft. of air per hour.

The ventilation system should ensure a complete change of air eight times per hour. This is the theoretical standard for housing natural-draught machines. In practice the operator should use his discretion. He should know whether or not the room is well ventilated. If in doubt he should provide too much ventilation rather than too little, because, as already pointed out, lack of fresh air, particularly during the later stages of incubation, may result in the death of many of the embryos. It will certainly lower the vitality of the chicks.

The incubator room should be of ample dimensions for the purpose, and provision should be made for possible increase of incubation capacity. Very frequently this is not done. A room is built to house a few machines, and gives satisfactory results. In the course of a few years the business develops, and additional incubators are purchased and placed in the same room, resulting in overcrowding, unsatisfactory hatching and general loss of efficiency. The poultry-farmer should always build with possible expansion of his business in mind. This

is a matter that concerns all phases of production, and is discussed elsewhere in so far as it relates to area of land and farm lay-out

For small natural-draught machines the room should be sufficiently large to allow a clearance of at least 12 in between the back of the machines and the wall, and not less than the same clearance between each incubator In addition, ample room should be provided for removing the egg-trays and attending to the eggs

With regard to housing forced-draught machines, the purchaser should consult the manufacturers The majority of firms supply plans of suitable buildings and employ technical experts who visit the farm and give advice on the spot

Light in the incubator-room is merely a matter of convenience, it has no influence on incubation Where windows are provided they should be comparatively small, and should be fitted in the north and north east side of the room

Incubator rooms should be used exclusively for the purpose They should not be regarded as store-rooms for sundry equipment They should be kept clean and tidy and free from dust

Furnishing should include a cupboard (for spare parts), a large substantially constructed table or bench, and an egg-testing table, preferably mounted on wheels if intended for use in large houses containing several machines

It is an advantage to have a vestibule entrance, or an office or store may be built at the end of the room to avoid direct entry This is a point of considerable importance, because in the winter months it is most undesirable to have gusts of cold air entering the room when the door is opened

When incubation is undertaken on a large scale it is a good plan to have office, egg storage, incubator, sexing, packing and washing rooms under one roof The lay out should be planned with a view to economy of labour and the maintenance of a high standard of hygiene

Different processes should be carried out in separate rooms, which should be so arranged that eggs and chicks pass from room to room in sequence For instance, it should not be necessary to take egg cases into the incubator room or to bring chick boxes through it Sexing should be carried out in a separate room Washing facilities should be provided next to

the incubator room or hatching room if the machines are of the separate hatcher type.

Some chick producers have a room or chamber in which eggs are fumigated before they are passed into the traying room, *i.e.*, the room in which eggs are packed into the incubator trays.

Some type of space heating of the buildings is essential in commercial chick production.

Electric heaters are frequently used, but many of the larger hatcheries have installed a hot-water system—pipes or radiators—with oil-fired boilers or boilers fitted with mechanical stokers.

Natural-draught Incubators. Natural-draught, or sectional incubators, as they are sometimes called, are usually of small capacity compared with those employing forced draught.

These incubators vary in size from the twenty-five-egg machine to a capacity of about 260 eggs, those of 100–150-egg capacity being the most popular. Larger machines of this type are built in sections, each section having independent temperature and ventilation control and holding about 150 eggs. They are heated by hot-water pipes connected with a coal-burning stove or oil-heater at one end. They have been almost superseded by the modern mammoth incubator.

The 100 260-egg machines have retained their popularity among small poultry-farmers, but on the larger pedigree and commercial farms cabinet incubators have replaced them.

Hot-water Incubators. Natural-draught incubators are of two types: hot-water and hot-air. The former consist of a hard-

Two thermometers are provided. One is used in the egg-drawer, and is inserted in a hole in the front of the drawer, the bulb of the thermometer being just clear of the eggs; the other is used for reading the temperature of the water in the tank. Over the tank in the front part of the incubator is the so-called drying-box, where chicks may be placed for some hours before their removal to the brooder.

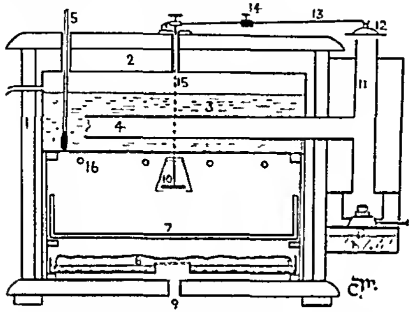

FIG. 73.—SECTION OF HOT-WATER INCUBATOR

1. Wood casing
2. Insulation.
3. Water tank
4. Flue.
5. Thermometer.
6. Lamp
7. Egg-tray.
8. Water-tray.
9. Air inlet.
10. Capsule.
11. Flue.
12. Damper.
13. Damper rod
14. Weight for adjusting temperature.
15. Push rod
16. Air outlets

Hot-air Incubators. These machines differ in principle from hot-water machines in that the air flows through a jacket in the lamp chimney and passes into the top of the machine, then through a hessian-covered frame into the egg chamber, passing out of the machine through spaces in the boards at the bottom.

Below the egg-tray is a nursery drawer, and below this, covering the bottom boards, are two felts that control the rate at which air flows through the incubator.

Moisture is provided by a trough attached to the lamp-flue

the incubator room or hatching room if the machines are of the separate hatcher type.

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The 100–260 egg machines have retained their popularity among small poultry farmers but on the larger pedigree and commercial farms cabinet incubators have replaced them.

Hot water Incubators. Natural draught incubators are of two types: hot water and hot air. The former consist of a hardwood cabinet with a water tank mounted above the egg-drawer and a water tray fitted below the latter. In some models tubular hot water heaters are employed.

Air enters these machines through ventilators in the bottom. It passes through the centre of the water tray, over which is spread hessian cloth on a perforated metal frame, the edges of the cloth being in the water. This enables the air to absorb moisture. It then passes through the egg tray to the top of the hatching compartment, where it leaves the incubator through small ventilators in the sides of the machine. The incubators are insulated with suitable material packed between the inner and outer walls.

Two thermometers are provided. One is used in the egg-drawer, and is inserted in a hole in the front of the drawer, the bulb of the thermometer being just clear of the eggs; the other is used for reading the temperature of the water in the tank. Over the tank in the front part of the incubator is the so-called drying-box, where chicks may be placed for some hours before their removal to the brooder.

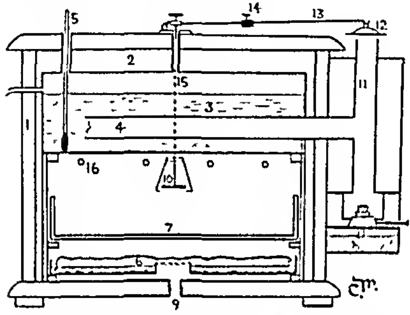

FIG. 73—SECTION OF HOT-WATER INCUBATOR

1. Wood casing	7. Egg tray.	13. Damper rod
2. Insulation	8. Water tray.	14. Weight for adjusting temperature
3. Water tank	9. Air inlet.	
4. Flue.	10. Capsule	15. Push rod
5. Thermometer.	11. Flue.	16. Air outlets
6. Lamp	12. Damper	

Hot-air Incubators. These machines differ in principle from hot-water machines in that the air flows through a jacket on the lamp chimney and passes into the top of the machine, then through a hessian-covered frame into the egg chamber, passing out of the machine through spaces in the boards at the bottom.

Below the egg-tray is a nursery drawer, and below this, covering the bottom boards, are two felts that control the rate at which air flows through the incubator.

Moisture is provided by a trough attached to the lamp flue

the incubator room or hatching room if the machines are of the separate hatcher type.

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Hot-water Incubators. Natural-draught incubators are of two types: hot-water and hot-air. The former consist of a hardwood cabinet with a water-tank mounted above the egg-drawer and a water-tray fitted below the latter. In some models tubular hot-water heaters are employed.

Air enters these machines through ventilators in the bottom. It passes through the centre of the water-tray, over which is spread hessian cloth on a perforated metal frame, the edges of the cloth being in the water. This enables the air to absorb moisture. It then passes through the egg-tray to the top of the hatching compartment, where it leaves the incubator through small ventilators in the sides of the machine. The incubators are insulated with suitable material packed between the inner and outer walls.

The front of the hot-air machines is usually fitted with a glazed frame opening outwards and downwards. This permits the operator to read the thermometer, which, unlike that in a hot-water machine, is suspended from the top of the hatching compartment, a little forward of the centre.

At hatching-time chicks are attracted by the light, find their way to the front of the machine, and there fall to the nursery below through a section of the egg-tray removed for this purpose.

Management of Natural-draught Incubators. Before operating

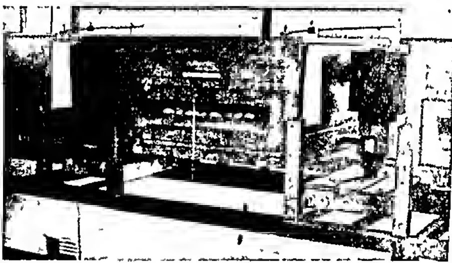

Photo Modern Poultry Keeping

FIG. 75.—THE SMALL NATURAL-DRAUGHT INCUBATOR
A hot-air model with oil-burning heater

these machines it should be seen that they stand perfectly level, by testing with a spirit level.

The capsule should be tested by holding it between finger and thumb and plunging it into water at about 102° or 103° F. It should immediately expand, and on placing in cold water contract until flat again. Should it fail to react to this treatment it should be discarded at once.

The push-rod should be straight, and should not make contact with the tube through which it passes. The arm—*i.e.*, the strong steel bar that connects the push-rod with the damper—should also be straight, and should move freely. A drop of oil should be applied periodically to the fulcrum, and always at the beginning of the hatching season.

This is kept full of water. A wick attached inside the double wall of the lamp-flue, with its end in the water trough, ensures that the air entering the machine is humid. In some machines water troughs are also fitted on each side of the egg-chamber just over the egg-tray.

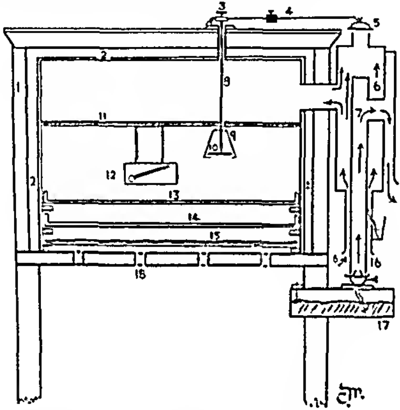

FIG. 73.—SECTION OF HOT-AIR INCUBATOR

1 Wood casing	7 Lamp flue.	13 Egg tray.
2 Insulation	8. Push-rod	14 Nursery-tray.
3 Set screw	9 Capsule stirrup.	15. Felts.
4 Damper rod	10 Capsule	16 Air inlet
5 Damper	11. Cloth diaphragm	17 Lamp.
6 Heater chamber.	12 Thermometer	18 Air outlets

In both hot-air and hot-water types temperature is controlled by a capsule. This expands at 100° F., and in doing so forces upwards a push-rod, which in turn lifts an arm of strong steel wire attached at one end to a fulcrum a little to the left of the push rod and at the other to the damper over the lamp-flue. As the capsule expands, therefore, it lifts the damper, and so allows the hot air to escape into the room, instead of entering the hot-water tank or hot-air chamber, as the case may be.

When the eggs are first placed in the incubator considerable time is required to raise the temperature. It is a good plan to have the machine running at 100–101° F. with the weight to the left, place the eggs in at night, and the following day move the weight to the right until the correct temperature is obtained.

Before commencing operations the water-tray and/or other moisture devices should be filled with water, and kept full throughout the period of incubation. In all normal circumstances there is no danger of providing too much moisture in a well-ventilated machine, but unless water-trays are kept full there is considerable risk of not providing sufficient.

Photo Modern Poultry Keeping

FIG. 76—LOADING THE INCUBATOR TRAYS ON A LARGE COMMERCIAL POULTRY-FARM IN THE SOUTH OF ENGLAND

Owing to the fact that conditions in the egg compartment are not uniform, when the eggs are turned a few should be taken from the centre to the outside edges of the tray and the remainder gently rolled towards the centre. Thus in the course of incubation the position of the eggs will be changed, ensuring that all are subjected to average conditions during the period.

In these machines the difference between the temperature

Thermometers should be tested by comparing their reading with that of a clinical or other thermometer known to be accurate. To test, hold the two thermometers together between fingers and thumb, with the bulbs at the same level, and dip them into warm water, gradually adding hot water until the temperature is brought up to 103° or 104° F. The readings of the two thermometers should, of course, agree.

Should the incubator thermometer be slightly inaccurate it may be used, provided allowance is made for its inaccuracy. The fault may be due to a split in the mercury column, which may subsequently unite.

Where oil lamps are used for heating they should be thoroughly cleaned, all carbon deposit being removed. It is advisable to start the season with new wicks.

Oil heated incubators of this type are readily converted for use with electricity. A number of firms supply conversion units.

In the hot water type of incubator the heating element is fixed in one of the flues, the other end being closed. The lamp fitting is, of course, removed.

In the hot air type of machine the heater is fitted in the lamp-flue, the outlet of the latter being closed. Temperature is controlled by a cut-out operated by the capsule or by a thermostat.

Several types of small electrically heated incubators are available.

At the beginning of the season, and when new machines are being used for the first time, they should be run empty for two or three days. This will ensure their being thoroughly warmed. The operator should make any necessary adjustments at this time.

During the short test run the temperature in the egg compartment should, of course, remain steady.

A lead weight which can be moved along the rocker arm controls the temperature by altering the pressure required to lift the damper. With this weight well to the left—i.e., near the fulcrum—the damper should rise when the temperature of the incubator reaches approximately 100° F. Then by moving the weight to the right the temperature can be brought up to the correct level.

When the eggs are first placed in the incubator considerable time is required to raise the temperature. It is a good plan to have the machine running at 100–101° F. with the weight to the left, place the eggs in at night, and the following day move the weight to the right until the correct temperature is obtained.

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Photo Modern Poultry Keeping

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stances there is no danger of providing too much moisture in a well-ventilated machine, but unless water-trays are kept full there is considerable risk of not providing sufficient.

Owing to the fact that conditions in the egg compartment are not uniform, when the eggs are turned a few should be taken from the centre to the outside edges of the tray and the remainder gently rolled towards the centre. Thus in the course of incubation the position of the eggs will be changed, ensuring that all are subjected to average conditions during the period.

In these machines the difference between the temperature

at the top of the egg and that at the bottom will vary somewhat in accordance with the temperature of the room. The colder the room the greater the difference between the top and bottom temperatures of the egg.

To ensure the correct temperature at the centre of the egg, the temperature of the incubator should be raised or lowered one degree for every ten degrees below or above the ideal (60° F.) in the temperature of the room.

TABLE 21

Room and Incubator Temperature (Natural-draught Machines)

Room temperature.	Incubator temperature.
40 deg. F	105 deg. F
50 "	104 "
60 "	103 "
70 "	102 "
80 "	101 "

As already stated, a slightly lower temperature is advised during the last week.

In hot-air machines both felts should be used during the first ten days, when one should be removed, the second being removed on the eighteenth day, providing the average room temperature is about 60° F. In cold rooms the first felt should be removed on the eighteenth or nineteenth day, and the second left in the machine for the whole period. In very warm rooms the machines should be run without felts during the last week.

In matters of this kind, however, discretion is necessary; every operator should be guided by his experience. He must study his conditions.

Testing the Eggs. Eggs are usually tested on the seventh or eighth day, and again on the fourteenth day. Most operators of cabinet incubators test only on the eighteenth day, as removal of infertile eggs on the sixth or seventh day necessitates re-loading of the trays

Testing is done in a darkened room either by holding the eggs individually before a strong light or by placing the tray on a testing table. The latter may consist of a frame with 60- or 75-watt electric lamps and reflector beneath. Some use a rather long table a little wider than the egg trays with an

aperture of appropriate size in the centre. Electric lamps are mounted in a reflector below the aperture.

For testing eggs individually a paraffin or electric lamp is enclosed in casing with a hole opposite the light rather less in diameter than the egg.

In natural-draught machines testing may be done by moving an electric lamp under the incubator tray.

Testing should be done in the incubator room.

The infertile eggs are known as "clears", and have the

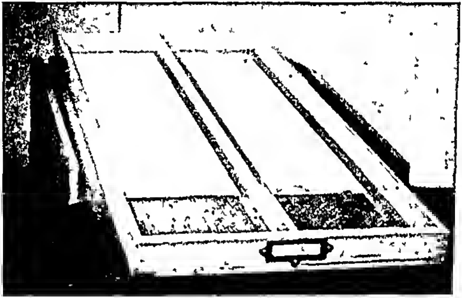

Photo: Modern Poultry Keeping

FIG. 77.—MASS TESTING OF HATCHING EGGS

This is easily arranged by placing the tray over electric lamps as shown

appearance of new-laid eggs, except for a slightly larger air-space.

For practical purposes all eggs having this appearance are regarded as infertile, although in fact some clear eggs are actually fertile, but the germs die in the very early stages of incubation.

The first test on the sixth or seventh day is mainly for the purpose of removing clears. But some eggs will show a dark spot moving freely when the egg is rotated. This is a dead germ. Other eggs may show a blood-ring in the yolk. This is due to the early death of the embryo when the blood separates

out to the edge of the vascular system. Should a large number of eggs show blood rings, prolonged under-heating or over-heating of the machine (most probably the former) should be suspected. A dark line running through the yolk is evidence of a broken yolk.

All eggs having the above appearances should be removed at the first test.

A fertile egg at this stage contains a dark spot (the embryo) with a series of veins radiating from it, giving the characteristic spider's web appearance (see page 203).

On the fourteenth day fertile eggs are becoming opaque, they are reddish in appearance, with some visible veins and an enlarged air-space now well defined.

On the eighteenth day the egg is more or less opaque throughout, with the exception of the air space, now appreciably larger than on the fourteenth day. Dead germs, of course, show no further development since the previous test.

Cooling. Cooling eggs during the second and third weeks of incubation is frequently advised. Cooling merely for this purpose is unnecessary. Eggs are not cooled in forced draught machines, nor does a hen leave the nest in order to cool the eggs—she does so to attend to Nature's requirements.

In a well ventilated incubator, therefore, there is no need to cool the eggs; nevertheless, a moderate amount of cooling following turning during the second, and especially during the third, week will do no harm and may result in a better hatch if the machine is not well ventilated. Cooling should not be overdone: the eggs should be warm to the touch when returned to the machine.

Hatching-time. In the writer's opinion it is inadvisable *to "leave the machines alone" between the time the first egg* pips and the completion of the hatch. Conditions in natural-draught incubators are not ideal for baby chicks.

Frequently newly hatched chicks are in a distressed condition, gasping on account of lack of oxygen and/or high humidity in the incubator, not because they are too warm.

If chicks are kept under these conditions even for a short time their lungs may be affected, and although they do not die in the incubator, mortality in the brooder house may be very heavy owing to congestion of the lungs.

Moreover, should any of the chicks be affected with B.W.D., infection is likely to become widespread before they are taken from the incubator. The greatest infection of this disease usually occurs in the incubator.

For these reasons, therefore, it is advisable to remove all dry chicks from the hatching tray every six or eight hours.

With regard to the use of nurseries and drying-boxes, there can be no objection to this, provided they are sufficiently warm for day-old chicks. Many of them, unfortunately, are not, and may cause severe chilling. The temperature should always be checked before they are used, and it is well never to place a handful of chicks in drying-box or nursery, which should not be used until a reasonable number of chicks can be regarded as thoroughly dry.

Incubators are not designed for brooding purposes, and in view of the difficulties that may arise it is wiser to transfer the chicks direct from the hatching-tray to the brooder, where conditions are, or should be, very much more suitable for them.

If the brooder is maintained at a temperature of 90–95° F., and is free from draught, there is no risk of chilling; and the chicks have plenty of room and plenty of fresh air. That is surely better than leaving them in the incubator.

After the completion of the hatch, unhatched chicks, chicks killed because they are weakly or deformed and surplus cockerel chicks should be burned, buried or cooked and fed to pigs.

Disinfection of Incubators. After every hatch incubators should be thoroughly cleaned and disinfected. All loose fittings should be removed and washed with a 2 per cent solution of reliable coal-tar disinfectant or a 4 per cent solution of washing-soda. The interior of the machines should be washed, then sprayed with one of these solutions.

Should B.W.D. be present or suspected, incubators should be fumigated between the hatches. *In no circumstances should this be done in natural-draught machines during the course of incubation.*

Fumigation should be carried out as follows:

Remove capsule and thermometer, as considerable heat is generated during fumigation. Seal all ventilators by pasting

paper over them, and leave the inside of the machine wet. The temperature should be about 100° F.

Place in the bottom of the incubator an enamel bowl containing half an ounce of permanganate of potash, and pour over this one ounce of commercial formalin (40 per cent solution of formaldehyde). This will liberate formaldehyde gas. Care should be taken not to inhale the gas. Immediately close the

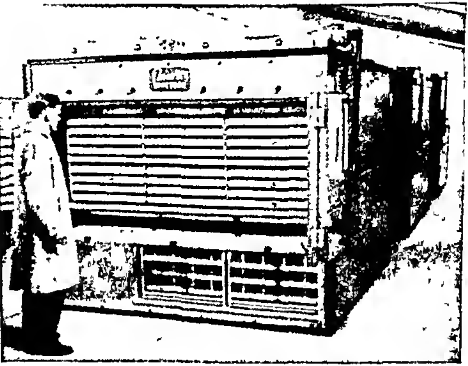

Photo: Poultry Farmer and Fancier

FIG. 78.—INCUBATORS EMPLOYING THE AIR DIFFUSION METHOD OF VENTILATION

Paddles revolve around the setting trays seen in the upper part of the machine. The hatching trays are below. These machines are of [illegible]-egg capacity—a weekly setting capacity of [illegible] eggs. Eggs are turned automatically every hour.

machine. After three or four hours open it, and allow it to air thoroughly before putting in hatching eggs.

The amount of permanganate of potash and formalin stated is sufficient for a 150-egg incubator.

In a well-ventilated room a machine can be fumigated without causing harm to eggs in other machines.

Cabinet (Mammoth) Incubators. Incubators of this class have become extremely popular in recent years. Whereas at

one time they were used principally by the larger hatcheries, they are now commonly employed on pedigree and commercial poultry-farms On the whole they are remarkably efficient, and may be relied upon to produce a chick from every hatchable egg

Capacity of these machines varies from about 900 eggs to over 98,000, *weekly settings from about 230 to 28,000 eggs* Some of the pre-fabricated machines are of the walk-in type, *i e*, the attendant enters them when carrying out certain tasks

Some of the large hatcheries have brick-built walk-in-type machines arranged in continuous rows with fully automatic control

Cabinet incubators save much labour and a great deal of space compared with the outmoded natural-draught or, as it is commonly termed, flat incubator

For example, twelve 150 egg capacity incubators would require a room of about 35 × 12 ft if single-tier machines were placed along each side, but a 2,000 egg capacity forced-draught machine could be operated in a room 12 × 10 ft, an 18,000-egg machine in a room 20 × 14 ft In each case it is assumed that electric heating is employed

The saving of space is effected by the arrangement of the egg trays, which are placed in tiers in racks It is usual to set one-third of the *egg-tray* capacity—*i e*, a quarter of total capacity—every week This means that the incubator is in continuous use throughout the season It is common practice to set the eggs in the late afternoon, taking off the chicks first thing in the morning of the day following three weeks later

For example, if the eggs are set late on Monday the hatch will be completed on the fourth Tuesday morning following

It is convenient to have the chicks ready in the morning, for this provides a full working day in which to deal with them

Eggs are tightly packed in trays commonly made of heavily galvanized wire with wooden frames, although some use all-metal trays

Cards showing breed or cross are inserted in slots in the trays The cards are usually of distinctive colour—red, white and blue are common—one colour being used for each hatch This facilitates the work of removing the trays to the *hatcher* or hatching compartment on the eighteenth day of incubation

Trays are not of standard size Those of some machines are

paper over them, and leave the inside of the machine wet. The temperature should be about 100° F.

Place in the bottom of the incubator an enamel bowl containing half an ounce of permanganate of potash, and pour over this one ounce of commercial formalin (40 per cent solution of formaldehyde). This will liberate formaldehyde gas. Care should be taken not to inhale the gas. Immediately close the

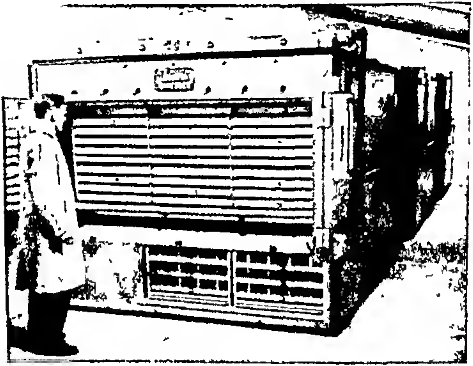

Photo: Poultry Farmer and Fancier

FIG. 78.—INCUBATORS EMPLOYING THE AIR DISPERSION METHOD OF VENTILATION

Baffles rest be around the setting trays seen in the upper part of the machine. The hatching trays are below. These machines are of 18,[illegible]-egg capacity—a weekly setting capacity of 4,[illegible] eggs. Eggs are turned automatically every hour.

machine. After three or four hours open it, and allow it to air thoroughly before putting in hatching eggs.

The amount of permanganate of potash and formalin stated is sufficient for a 150-egg incubator.

In a well-ventilated room a machine can be fumigated without causing harm to eggs in other machines.

Cabinet (Mammoth) Incubators. Incubators of this class have become extremely popular in recent years. Whereas at

one time they were used principally by the larger hatcheries they are now commonly employed on pedigree and commercial poultry-farms On the whole they are remarkably efficient, and may be relied upon to produce a chick from every hatchable egg

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Some of the large hatcheries have brick-built walk-in-type machines arranged in continuous rows with fully automatic control

Cabinet incubators save much labour and a great deal of space compared with the outmoded natural draught or, as it is commonly termed, flat incubator

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The saving of space is effected by the arrangement of the egg trays, which are placed in tiers in racks It is usual to set one-third of the *egg-tray* capacity—*i e*, a quarter of total capacity—every week This means that the incubator is in continuous use throughout the season It is common practice to set the eggs in the late afternoon, taking off the chicks first thing in the morning of the day following three weeks later.

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Eggs are tightly packed in trays commonly made of heavily galvanized wire with wooden frames, although some use all metal trays

Cards showing breed or cross are inserted in slots in the trays The cards are usually of distinctive colour—red, white and blue are common—one colour being used for each hatch This facilitates the work of removing the trays to the hatcher or hatching compartment on the eighteenth day of incubation

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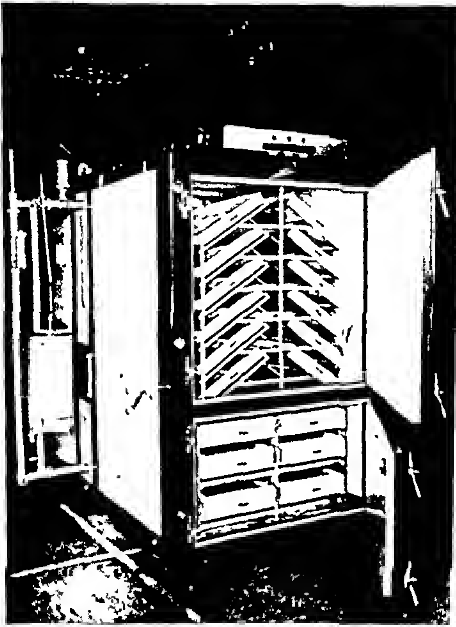


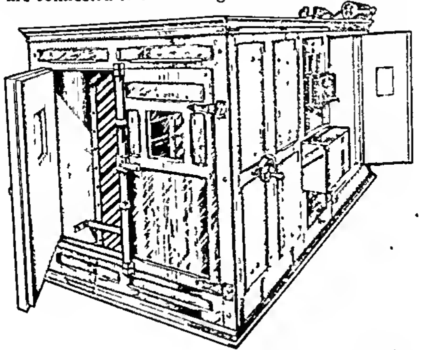
Photo. [illegible] Incubator Co., Ltd., Canada

FIG. 79.—A MODERN HOT-WATER CABINET INCUBATOR HAVING A TOTAL CAPACITY OF 5,632 EGGS

The heating apparatus is on the left. In the upper section are the egg trays. The hatching trays are below.

of about 120-egg capacity, while other machines will take up to 190 eggs per tray. Eggs should be placed in rows with the broad end upward, the ends of the rows being packed with paper to prevent movement. Some trays permit eggs to be packed on their sides.

In the setting compartment—the so-called setter—turning is accomplished by tilting the trays through an angle of 90°. The trays are connected to the turning mechanism.



Papworth Industries Cambridge

FIG. 80.—GENERAL VIEW OF A MODERN FORCED-DRAUGHT INCUBATOR

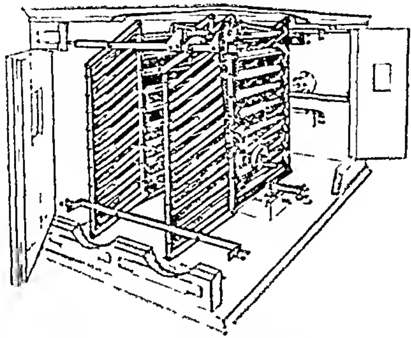
The picture shows one movement door lock, turning handle, moisture device and ¼-h.p. electric motor which drives the fan.

When operating cabinet incubators the eggs may be mass tested at the end of the first week to remove clears. As a rule, however, they are not tested at this stage, the usual procedure being to test them when they are transferred to the hatching compartment—the "hatcher"—on the eighteenth day. In the hatcher the eggs are placed on their sides. They are not turned at this stage.

In machines of this type, in which conditions are different from those often prevailing in natural-draught incubators, chicks are usually left on the trays until the completion of the hatch.

Some incubator manufacturers supply separate hatchers with their machines. This means in effect two machines, one for incubation up to the eighteenth day and the other to complete the hatch. This is an additional safeguard against disease and is an aid in maintaining a higher standard of sanitation.

Separate hatchers may be an integral part of the unit, each machine comprising a setting and hatching compartment.



Fawcett Industries Limited

FIG. 81.—THE TURNING MECHANISM OF A MAMMOTH INCUBATOR

In the larger plants, however, separate machines for setting and hatching respectively are now most commonly employed.

In some hatcheries walk-in setters and hatchers are built in parallel blocks, the trays being loaded on one side of the setters. On the eighteenth day they are taken from the other side to the testing tables in the corridor between the two blocks, then to the hatchers, and finally the chicks are removed from the side of the hatchers opposite the loading side. This ensures one-way traffic.

Cabinet incubators differ from the sectional type not only in size, but also in the method of ventilation and general plan.

Two methods of ventilation are employed. One method is

termed "air dispersion", or agitation by paddles, the other is forced-draught or direct-air circulation In the former cool air is drawn into the machine and passes through or near heaters. As the warm air rises it is mixed with the air in the machine by means of large fans or paddles These paddles

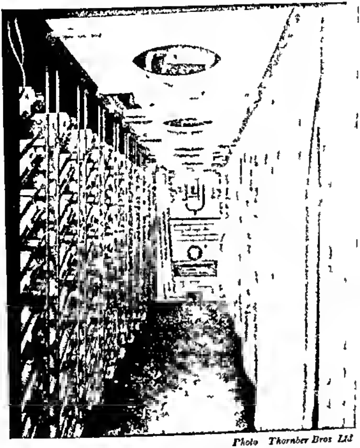


Photo Thornber Bros Ltd

FIG. 82—A "WALK-IN" TYPE OF INCUBATOR SHOWING THE SETTING TRAYS

The curtains are of plastic material Apparatus for the control of humidity is fitted to the top of the rear wall

cause the air to circulate throughout the egg or setting compartment, and it is finally forced out through the outlet holes of the machine by the pressure of incoming air

In forced-draught incubators air is drawn into the machines by fans. Thereafter it follows the same course as in machines employing the air-dispersion principle. The two systems of ventilation have proved equally satisfactory.

Cabinet machines are of two types: the hot-water and hot-air types. In the former the air is heated by hot-water pipes or radiators, the water being heated on the outside of the machine by a blue-flame paraffin lamp, gas or electric heating unit. Temperature control is effected by a capsule on the same principle as that adopted in sectional hot-water machines and by a thermostat. The fans are driven by an electric motor or small petrol engine, where electric power is not available.

Hot-air machines are similar in construction to the hot-water cabinet, with the exception that heat is provided by electricity, controlled by a thermostat.

Optimum temperature for incubation is between 99° and 100° F. Makers' directions should be followed with regard to temperature and general management.

The heat control is so efficient that the temperature will remain constant within half a degree, and relative humidity can be kept at the correct level—that is to say, 60 per cent and 70 per cent at hatching-time.

The eggs will therefore lose the proper amount of moisture, and none of the troubles arising from the lack or excess of evaporation will occur.

For practical purposes evaporation can be judged by examination of the air-space. According to Lippincott, the depth of the air-space in a 2-oz. egg should be $\frac{11}{32}$ in. on the eighth day, $\frac{16}{32}$ in. on the fourteenth day, and $\frac{21}{32}$ in. on the nineteenth day.

Lippincott quotes the table below showing the loss of weight of 100 eggs (from data by Attwood).

In order to maintain more favourable atmospheric conditions in the incubator some makers fit flues to the exhaust ports to

Table 22

Loss of Weight of 100 Eggs during 19 Days' Incubation

Days	Ounces	Days	Ounces	Days	Ounces
1	1·65	7	11·72	13	22·10
2	3·31	8	13·44	14	[illegible]
3	4·96	9	15·16	15	[illegible]
4	6·62	10	[illegible]	16	[illegible]
5	8·28	11	18·60	17	[illegible]
6	10·00	12	20·33	18	[illegible]
				19	[illegible]

carry the air out of the building. In some models the air entering the machines is heated outside the setting compartment, warm-air ducts leading to the inlet ports of the latter.

In large-scale chick production "walk-in" type incubators are becoming common. They may be of brick construction or pre-fabricated and in fact consist of a series of setting and hatching-rooms sufficiently large to enable the operator to

Photo Western Incubators, Ltd

FIG. 82A.—PRE-FABRICATED WALK-IN INCUBATORS

A bank of five pre-fabricated walk-in incubators comprising part of a large broiler chick hatchery. Each machine has a total capacity of 98 280 eggs, a total weekly setting capacity of 28 080 eggs

walk into them to attend to the eggs and chicks. Temperature, humidity and air circulation are independently controlled in each room.

Alarm System. Cabinet incubators should be fitted with an alarm system to warn the operator should the temperature fall below or rise above normal. The alarm should be connected with his bedroom at night, when failures seem to occur most frequently, although no doubt data would disprove this.

Current failure may cause serious trouble if prolonged, but if the heating were cut off for a few hours little harm would

result, because the eggs and the machine would lose heat slowly.

Jull quotes the results of tests conducted by the California Experimental Station, where it was demonstrated that with a room temperature of 70° F. a twelve-hour current failure caused an average decrease in hatchability of 3·4 per cent.

Marshall (1950) suggests that when the period does not exceed three hours, no action need be taken beyond closing the outlet damper. Should the failure be prolonged, the use of an ordinary pressure lamp of the carrying type is advised, the temperature of the incubator being kept as near as possible to 100° F. by opening and shutting the door or leaving it ajar. At intervals the fans should be turned by hand to break up temperature gradients.

Marshall also recommends turning the eggs every fifteen minutes until normal incubating temperature is restored.

Troubles other than those due to current failure may occur—*e.g.*, breakdown of motor, sticking of the thermostat, and "shorts" in the machine.

Fumigation of Forced-draught Incubators. Routine fumigation of cabinet incubators should be carried out as a precaution against B.W.D.

For this purpose it is customary to use 3 oz. formalin (40 per cent formaldehyde) and 2 oz. permanganate of potash for each 100 cub. ft. (internal measurements) of incubator space.

When these small quantities of formalin and permanganate of potash are used, it is essential to ensure high relative humidity in the incubator—*i.e.*, about 68 per cent (wet bulb reading of 90° F., dry bulb 100° F.).

More recently, however, much greater quantities have been recommended, because it has been found that the small quantities previously employed, while normally sufficient to destroy *Salmonella pullorum*, were not effective against other *Salmonella* infections (Salmonellosis).

To ensure destruction of these organisms and those responsible for omphalitis (navel ill), and possibly other egg-borne infections, 1½ oz. of formalin and 3 oz. permanganate of potash should be used for each 100 cub. ft. of incubator space.

Fumigation should be carried out between the twenty-fourth and eighty-fourth hours after setting the eggs in the machine.

but it can be done at any other time without detriment to the embryos. Hatched chicks should not be exposed to the gas.

From six to eight hours after the eggs are set is a suitable time for fumigation, but if desired the work may be done immediately after the eggs are put in the machine.

The organisms responsible for Salmonellosis are capable of penetrating the egg-shell when exposed to incubation conditions. In order, therefore, to destroy infection which may be present on the egg-shell, the earlier fumigation is carried out, the less risk there is of penetration occurring. For this reason, some hatcheries fumigate in an air-tight cabinet immediately prior to setting the eggs, using $4\frac{1}{2}$ oz. formalin and 3 oz. permanganate of potash per 100 cu. ft. Temperature of cabinet need not be raised, since this amount of formalin provides a margin of activity to offset the slight lowering of efficiency caused by its use at atmospheric temperature.

The correct quantity of permanganate of potash should be placed in a tin or other suitable container, which should stand in a bucket to catch any overflow of material likely to occur when the gas is liberated. The bucket should then be placed in a central position on the floor of the incubator and the correct volume of formalin poured over the permanganate of potash crystals.

The incubator should be closed immediately (but the fan should be kept running) for not less than twenty minutes. Incubator ventilators should be closed for the first five minutes of fumigation, otherwise a large proportion of the gas will escape.

Excess formaldehyde remaining after fumigation can be removed by sprinkling ammonia solution on the incubator floor or by placing a bowl of ammonia solution in the air intake duct without fear of reducing the efficiency of the fumigation process. A volume of 33 per cent ammonia solution, equal to half that of the formalin used, is normally required.

Separate hatchers should be fumigated after the chicks have been removed, but before the trays and debris have been taken from the machine.

Great care should be taken by the operator to avoid contact with formaldehyde gas, as it is a strong irritant affecting, particularly, the eyes, nose and throat. It is advisable to wear a gas-mask.

It is suggested that fumigation with the smaller quantities

of formalin and permanganate of potash should be carried out as a matter of routine, the larger quantities being used only in the event of an outbreak of Salmonellosis.

Where, however, hatching eggs are purchased from a number of farms, it is desirable to use the larger quantities.

The trays and other movable parts should be taken out and scrubbed with a detergent solution containing a disinfectant such as sodium hypochlorite. The fluff should be removed with a vacuum cleaner, and the debris and egg-shells burnt or buried. Special notes relating to the fumigation of incubators are contained in the Poultry Stock Improvement Plan Regulations 1960/61. The recommended procedure in fumigating incubators with combined setting and hatching compartments and those with separate hatching compartments is described.

In addition, the notes include information with regard to hatchery hygiene, the use of approved disinfectants and other measures contributing to disease control.

Vibration. In all normal circumstances vibration has no injurious effect on hatching eggs. It should be remembered that the embryo is well insulated against shocks, and fairly violent shaking would be needed to cause injury. Moreover, the vibration set up by the fans in some forced-draught incubators is greater than that likely to be caused by traffic on nearby roads, yet these machines hatch normally.

Knox and Olsen have shown that jarring eggs held large end downwards readily produced tremulous air cells, but jarring did not affect hatchability of the eggs unless it produced tremulous air cells.

Common Reasons for Failures in Incubation. Probable reasons for certain forms of failure are as follow :—

Result	Probable reason
(1) Delayed hatch	Low average temperature
	Stale eggs
	Variable room temperature
(2) Early hatch	High average temperature
In (1) and (2) care should be taken to ensure that the thermometer and heat-control mechanism are in proper order	
(3) Dead in shell with small air spaces	Insufficient ventilation of machine and/or room [illegible]
	Low [illegible] of eggs
(4) Dead in shell with large air spaces	Lack of moisture
	Temperature too high
(5) Dead in shell with normal air space	Poor condition of breeding stock
	Lack of [illegible]

Result.	Probable cause.
(6) Blood rings.	Early death of embryo. Too high or too low temperature.
(7) Sticky hatches. Pieces of shell sticking to chicks	Lack of moisture. Too high a temperature.
(8) Sticky hatches. Chicks smeared with egg contents	Excess of moisture. Too little ventilation. Temperature too low.
(9) Crippled chicks	Great variation in temperature.
(10) Broken yolks	Constitutional. Some birds produce eggs having weak yolks. Severe shocks during transport. Incorrect turning.
(11) Clear or infertile eggs	Incorrect proportion of males to females. Fighting among males. Underfeeding. Frozen combs. Lack of shelter.
(12) Small chicks.	Small eggs. Insufficient moisture.
(13) Weak chicks.	Too high or too low temperature.
(14) "Mushy" chicks. Navel infection or omphalitis	Insanitary conditions, in incubator and incubator house.

Hatching Pedigree Chicks. The pedigree-breeder must be able to identify individual chicks in order that they may be marked to the sire and dam.

This is done by writing the trap-nest number of the hen on the egg when the bird is released from the nest.

In mammoth incubators all the eggs from one hen or one pen should be placed together for convenience. If the eggs are placed in various parts of the hatching-tray or divided between different trays, time is wasted in collecting them together when transferred to the hatching compartment.

Trap-nest numbers should be written on the rounded ends or sides of the eggs. They should be marked in bold, distinct figures, to avoid the possibility of error.

On the eighteenth day all the eggs from each individual hen in the pedigree pens are placed in small wire cages. These cages should be numbered by placing a piece of paper or card inside them or by some other means, because it is impossible to rely on identifying the chick from the number written on the shell.

Wire cages are made to hold one or more eggs. It is convenient to have two-, four- and six-egg-size cages.

In small natural-draught machines wire cages may be too large to give clearance between them and the capsule or thermometer. In these circumstances bags made of butter-muslin should be employed. The bags should be large enough

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Result	Probable reason
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(2) Early hatch	High average temperature
In (1) and (2) care should be taken to ensure that the thermometer and heat-control mechanism are in proper order	
(3) Dead in shell with small air-spaces	Insufficient ventilation of machine and/or room [illegible] Low [illegible] of eggs
(4) Dead in shell, with large air-spaces	Lack of moisture Temperature [illegible]
(5) Dead in shell with normal air-space	[illegible] Lack of [illegible]

Result	Probable reason
(6) Blood rings	Early death of embryo Too high or too low temperature
(7) Sticky hatches Pieces of shell sticking to chicks	Lack of moisture Too high a temperature
(8) Sticky hatches Chicks smeared with egg contents	Excess of moisture Too little ventilation Temperature too low
(9) Crippled chicks	Great variation in temperature
(10) Broken yolks	Constitutional Some birds produce eggs having weak yolks Severe shocks during transport Incorrect turning
(11) Clear or infertile eggs	Incorrect proportion of males to females Fighting among males Underfeeding Frozen combs Lack of shelter
(12) Small chicks	Small eggs Insufficient moisture
(13) Weak chicks	Too high or too low temperature
(14) "Mushy" chicks Navel infection or omphalitis	Insanitary conditions, in incubator and incubator house

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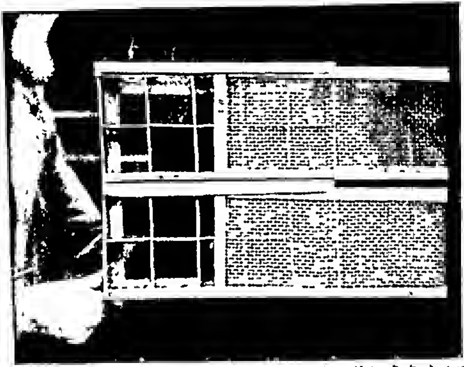


Photo Modern Poultry Keeping

FIG. 83.—A SET OF PEDIGREE HATCHING-CAGES FOR INDIVIDUAL HATCHING

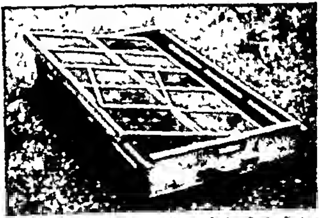


Photo Modern Poultry Keeping

FIG. 84.—ANOTHER TYPE OF PEDIGREE EGG CAGE

A wooden frame made of [illegible] the hatch or tray. Each section has a hinged wire cover.

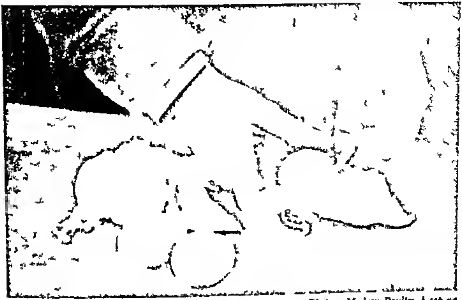


Photo Modern Poultry Keeping

FIG 85 —PLACING EGGS IN PEDIGREE HATCHING BAGS
The bags are made of coarse butter muslin

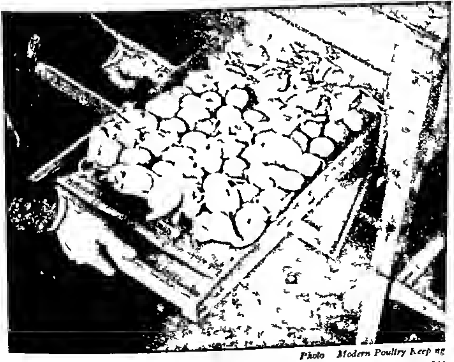


Photo Modern Poultry Keeping

FIG 86 —EGGS FROM PEDIGREE BIRDS ON THE INCUBATOR TRAY ON THE EIGHTEENTH DAY

to give the chick freedom of movement at hatching-time. String or tape should be threaded through the top hem and tied, to prevent the chick escaping.

The number of the egg should be written on a small card placed in the hatching-bag, or the latter may be numbered outside and a note made of it when the egg is put inside.

Marking Baby Chicks. Pedigree chicks must be marked when removed from egg-cage or bag. Marking may be done by leg-rings, wing-bands or toe-punch.

Leg-rings are not recommended. It takes a long time to attach them, they are apt to come off, and they must be changed as the chicks grow. This entails a considerable amount of unnecessary work.

Wing-banding is far more satisfactory. By this method the chicks are marked by attaching a numbered aluminium band or metal tab to the wing when the bird is marked for life. If they are properly attached the number of bands likely to be lost is negligible.

Bands are attached as follows. The wing is fully extended, and in the large flap of skin in front of the " elbow " joint the point of a sharp penknife is forced about ¼ in. from the edge. In the slit thus formed, thread the wing-band, bring the ends together and fasten them, taking care not to pinch the skin.

An excellent type of wing-band is one that is riveted by means of a small hand-operated riveting machine resembling a pair of pliers.

Wing-tabs are attached on the safety-pin principle.

When the chick is marked, its number must be entered in the record card or book at once. Loose pieces of paper should never be used for this purpose, even as a temporary measure, for they are likely to be lost, and a lost record destroys all the work of the breeder in so far as the particular chick is concerned.

The number of the chick should be entered in the hen's record card and duly filed.

Toe-punching. Chicks may be marked by punching a hole or holes in the web between the toes. Toe-punches are available at the usual stores catering for the poultry-farmer.

There are sixteen possible markings by the toe-punch, making

a circular hole, but it is also possible to a half-circle in the edge of the web or

Each breeding-hen (or pen) shou' marking, and all markings should be re a card-index system

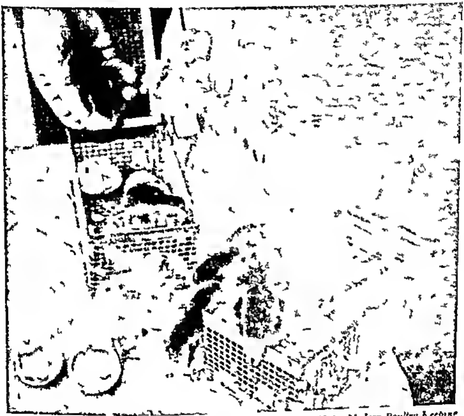


Photo Modern Poultry Keeping

FIG 87 —PEDIGREE EGG CAGES

Pedigree egg cages are used in preference to bags by most breeders The baby chicks in this picture are Legbars A cockerel is in the operator s left hand a pullet in his right

Chicks should be examined a few days after marking to make sure that the skin is not growing over the holes

It will be understood that this system of marking offers limited scope compared with that of the wing band, and where it is practised throughout the season it is impossible for the breeder to identify chicks hatched at different times of the year Nevertheless the method is extremely useful, and is commonly adopted on pedigree farms

Temporary Marking If for any reason the breeder wishes to

identify certain chicks and prefers not to mark them at the time they are removed from the incubator they may be marked temporarily by daubing the back with aniline dye. This will enable the breeder to identify the chicks until they are about a fortnight old when wing bands or leg rings should be attached.

Destruction of Day-old Chicks. During the spring when the maximum demand for day old pullets occurs, breeders and hatcheries may have a surplus of day old cockerels which must be destroyed.

Several methods of mass destruction have been employed, some of which cause much suffering.

The problem was studied by Harry, Gordon and Tucker (1955), who concluded that the most satisfactory method of killing chicks in large numbers is by gassing with the exhaust gas of a petrol engine.

A suitable gastight chamber or box should be constructed with an inlet in the side near the base and an outlet in the top which can be opened and closed in accordance with the rate of flow of the gas.

Flexible tubing should be used to connect the exhaust pipe of the engine with the lethal chamber.

The engine should be run at minimum speed with as much choke as possible without producing soot.

Harry, Gordon and Tucker state that the chamber should be left sealed for a minimum time of three minutes after it has been filled with gas. Care should be taken to avoid a high temperature in the lethal chamber. If necessary they recommend cooling the exhaust gas in a water jacketed pipe.

For small scale destruction chloroform appears to be the most efficient and is best used with an R.S.P.C.A. container. Two fl. oz. of chloroform is required for a box 17 × 17 × 30 in. It should be vaporized in the upper part of the container, which should be sealed for 10–15 minutes, the longer period in cold weather.

Chapter Ten

Chicken Rearing

Artificial Rearing. *Rearing Appliances* The number of rearing appliances now available is legion There are brooders of every conceivable type and size, heated by oil, coal, electricity, water or gas, some are suitable for indoor use (intensive rearing), others for outdoor use, while many may be used either in large houses where the chicks are reared in confinement or in small portable houses where they have grass runs

Hay-box Brooders Perhaps it will be of interest first to describe the hay-box brooder, in which no artificial heat is employed

These brooders are home-made, so that it is impossible to give a description of what may be termed a standard type. The question is one of principle rather than of design

Hay-box brooders used by one successful rearer are arranged in four tiers, each with a wire-floored run The hay box consists of an outer framing of four 6-in boards, approximately 2 ft 3 in long with four 1-in -diameter holes drilled in the top The floor is made of ½-in -mesh wire netting, tightly stretched to prevent sagging

The nest is made of a central circlet of wire netting with an opening at the pop-hole, which should be arranged to lead directly into the run—*i e*, there is no "half entrance" between pop-hole and nest

Hay is stuffed very loosely between the sides of the box and the circlet of wire forming the nest, which is also hay lined The top is covered with a piece of felt or a sack

The run is the same width as the hay box, and is about 5 ft long

A hay box and run of the dimensions stated will accommodate seventy chicks up to four weeks old

As the chicks grow, the nest is enlarged by expanding the

length of netting, and the amount of hay stuffing surrounding it is gradually reduced, as less heat is required.

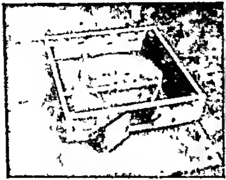


FIG. 88.—THE HAY-BOX BROODER, SHOWING CONSTRUCTION OF NEST

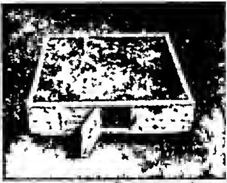


Photo: Modern Poultry Keeping

FIG. 89.—THE NEST IS LINED WITH HAY, AND HAY IS LOOSELY STUFFED BETWEEN NEST AND FRAMING

If well housed, these brooders may be relied upon to rear first-class chicks throughout the season, and no one need hesitate to use them even in severe weather.

The one great disadvantage from the commercial standpoint

FIG. 90.—A FOUR-TIER BLOCK OF HAY-BOX BROODERS

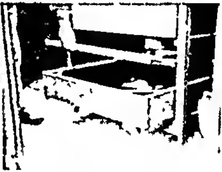


Photo: Modern Poultry Keeping

FIG. 91.—HAY-BOX BROODING

For the second stage the hay and nest are removed. Strips of wood across the corners raise the lid and thus provide adequate ventilation.

is that the chicks require very close attention during the first week. They must be moved out of the nest at feeding-time and then gently pushed back again and the pop-hole closed. Since this has to be done five or six times a day, it will be realized that the work entailed is considerable.

After the first week, however, the chicks will know their way about and require very little attention From this age the pop-hole is left open during the day, the birds running in and out of the nest at will

Pellets or moist mash should be fed for the first few days This enables the chicks quickly to fill their crops and return to the hay box When they are about a week old they may have an all-dry-mash ration

The same principle may be adopted for chicks over four weeks of age, with the exception that at this stage no hay will be necessary and care should be taken to ensure adequate top ventilation For this reason it is advisable to use a wooden cover slightly raised on cross-pieces fixed at each corner. Alternatively, a frame covered with hessian cloth may be used

Home-made Brooders. A simple type of home-made brooder that is extremely popular is built round a small brooder heater, but may be heated with an ordinary 40-watt electric lamp or a 25-watt carbon filament lamp (Fig 92).

The brooder consists of a box (without lid) about 3 ft 6 in or 4 ft long, 18 in wide (internal measurement) and 12 in deep It should be made of sound T and G ¾-in matchboards

Inside the box should be nailed 1-in-square battens 7 in from the floor on each side They support the canopy, which should be 17½ in wide and about 18 in long, with a hole in the centre to take the chimney of the heater (or the electric lamp-holder) If an electric lamp is used, a metal deflector should be fitted to throw down the heat

On both the open sides of the canopy should be attached strips of baize or flannel to form the curtains They should be long enough just to touch the litter

A pop-hole should be fitted in one end of the box

For baby chicks the canopy should be pushed to the end of the box opposite the pop-hole, and should fit flush with the end board

As the chicks grow the canopy should be moved a little towards the centre, so that when they are three to four weeks old it occupies a central position This ensures more uniform distribution of the chicks and better ventilation

As they become accustomed to their surroundings, the chicks should have the use of a small run outside the brooder

A brooder of this type will rear twenty-five to fifty chicks up to five or six weeks old. It may be used in any well-constructed house.

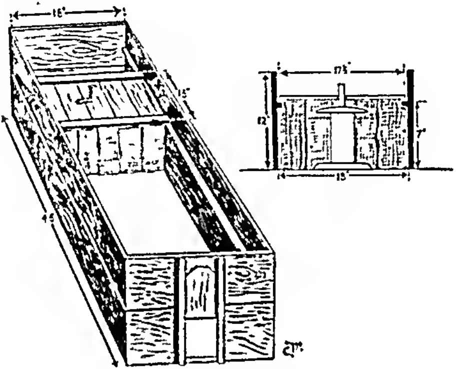


FIG. 92.—HOME-MADE BROODER WITH BROODER STOVE

Foster-mothers. The earlier types of outdoor brooders were known as foster-mothers.

They are still used on a number of farms to-day, although they have been largely superseded by the cheaper and more adaptable hover.

The old type foster-mother consists of a brooding section proper. This is lined with matchboards, three-ply, asbestos cement or composite board. This lining, in addition to preventing sudden changes in temperature, is also used to baffle the ventilation.

The lid of the brooding section is of metal, and over this is the roof of the brooder.

Attached to this section is a covered nursery with boarded floor and window. Some models have a third section without floor to provide a covered grass run.

Foster-mothers of the type described are comparatively expensive, and, since they cannot be used for other purposes, they represent considerable idle capital during many months

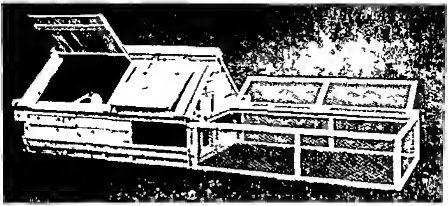


Photo Boulton & Paul Ltd, Norwich

FIG 93—BROODING AND REARING ARK

A 6 ft by 3 ft ark with a solid floor over a slatted floor, equipped with hover for rearing chicks from the day-old stage For growing stock the solid floor is placed under the slatted floor, the former is then used as a droppings board

of the year Moreover, those of the more orthodox design will not rear more than fifty chicks up to six weeks old

When using brooders of this type it is advisable to move the

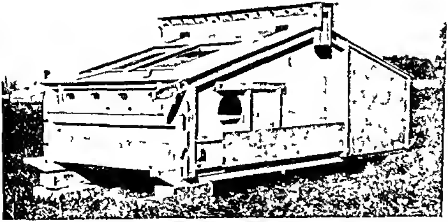


Photo D McMaster (Bures) Ltd Bures, Suffolk

FIG 94—A 100-CHICK-CAPACITY RESIN-BONDED PLYWOOD BROODER FOR OUT-DOOR REARING

chicks when about four weeks old to a carry-on brooder where they have more room.

Some rearers use foster-mothers under open sheds early in the season.

In the more modern types portable hovers are used, and the partition between the brooder and run or nursery section is removable. This increases the capacity of the brooders very considerably.

Further improvement has been effected by making the floor removable. In these models the hover is taken out when the chicks are six to eight weeks old, and the wooden floor is replaced by a slatted floor. Thus the brooder may be converted into a type of night ark, which will house about thirty growing birds up to the time they are moved to laying-houses.

In addition to this type of outdoor brooder there are many others designed for use on grass range.

They seek to overcome the disadvantages of the earlier types by providing the chicks with more space, thus reducing the capital cost of rearing equipment on a per-chick basis.

Some of these brooders resemble small full-span houses, both sides of the roof being movable. One side covers the brooding section proper. This is heated by a paraffin lamp, which may be placed under a baffle-plate, and over this a wire floor of ½-in. mesh, on which the chicks sleep. The other section of the brooder provides a nursery, also with a wire floor.

The chicks are confined to these brooders for a few days before being given access to a grass run.

Brooder Folds. These are similar in principle to the foster-mother, except that they give the chicks more room and may be used for the second stage of rearing—*i.e.*, from about six weeks of age, if desired. They have become very popular on a number of farms where importance is attached to rearing on grass range almost from the day-old stage.

It should be emphasized, however, that a considerable area of well-drained, level ground is essential for success, because unless the brooders can be moved to fresh ground daily, or at least every alternate day, one important benefit is lost. The ground must be level, or reasonably so, or heat will not be uniformly distributed in the brooding section. Further, using the brooders on uneven ground sets up strains that

may well cause damage affecting the efficiency of the entire unit.

Hovers. The hover is the most popular type of rearing appliance. It consists of a conical or pyramidal metal canopy with baffle-plate, the whole being mounted on metal supports. On the edge of the canopy a double row of baize curtains is commonly fitted to oil-burning and some electric models, the

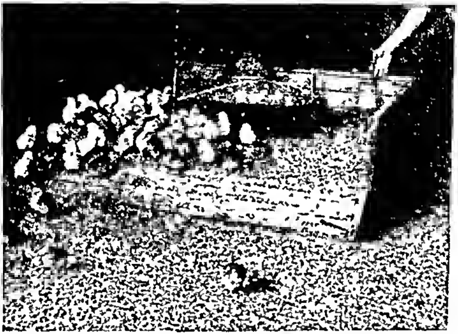


Photo Modern Poultry Keeping

FIG. 95—A POPULAR TYPE OF HOVER WITH NURSERY SURROUND

The hinged sides form a draught screen and prevent the chicks straying too far from the hover until they know their way back to it

curtains being slit at intervals so that the chicks may easily enter and leave the brooder.

Oil-burning hovers may be used in small portable houses or large multiple-unit houses. At the end of the rearing season they may be stored and the houses used for growing, and if necessary adult, stock. Since the hovers are comparatively cheap, their all-round economy is recognized.

Unfortunately, in order to reduce the cost of these appliances, some manufacturers use cheap and inadequate lamps. The heating unit is of great importance in brooding appliances,

and prospective purchasers should assure themselves that the lamp is not only soundly constructed, but also sufficiently powerful to provide a temperature of not less than 90° F. beneath the canopy even in severe weather. This temperature should be maintained without having to turn up the wick to near smoking point.

Some manufacturers supply hovers complete with wire floors and wooden surround, the latter confining the chicks to the vicinity of the hover for the first few days and, of course, acting as a draught-screen.

Photo: Modern Poultry Keeping

FIG. 96.—A BLUE-FLAME HOVER

Blue-flame hovers provide an abundance of heat and curtains are unnecessary. The oil consumption of this type of hover is rather high.

Wire floors are sanitary, and ensure better ventilation, but unless the lamp provides an abundance of heat it is usually advisable to cover the floor with coarse hessian cloth for the first few days, except in warm weather.

Blue-flame hovers have lost popularity in recent years, not because they are inefficient in principle, but because oil consumption is high, and this is not justified unless the chicks are reared in large groups.

Coal-burning hovers are rarely seen to-day, the reason being that, like the blue-flame hovers, they necessitate chicks being reared in large numbers if operative costs are to be kept at an economic level.

Electrically heated hovers are now widely used following the electrification of many rural areas. These hovers, being

thermostatically controlled, are usually highly efficient appliances. They are clean and labour-saving; operative costs compare favourably with oil-heated hovers.

Electric heating units of diverse types are available for the conversion of oil-heated appliances.

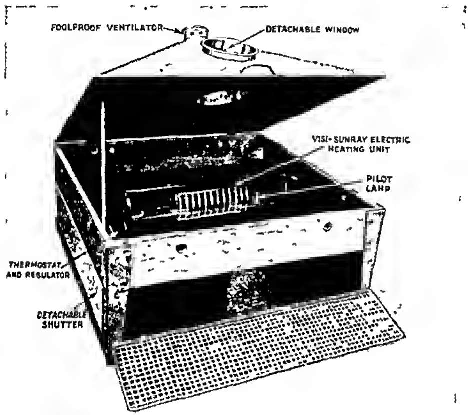


Photo Visi Chick Brooder Co., Ltd., Colne, Lancs

FIG. 97.—AN ELECTRIC HOVER IN WHICH THE TEMPERATURE IS THERMOSTATICALLY CONTROLLED

Note the wire floor and detachable shutters

In addition to the conventional type of hover there are models in which the principle of contact heating is applied. These hovers have an electrically heated pad under the canopy, the chicks obtaining heat by contact with it. Floor temperature under contact-heat hovers is, of course, much lower than in space-heated hovers. Some tier brooders are fitted with contact heating pads.

Electric brooding plants should be equipped with an alarm

This type of brooder is designed for rearing chicks in batches of about 1,000 for broiler production.

A broiler brooder of recent introduction comprises a comparatively small heater without canopy. It is suspended approximately 4 ft. 6 in. from the floor. Consuming petroleum or mains gas, each unit provides sufficient spread of heat for 1,000–1,250 chicks.

These units are thermostatically controlled, but the thermostats are not an integral part of the heater. They can be fitted in any suitable position.

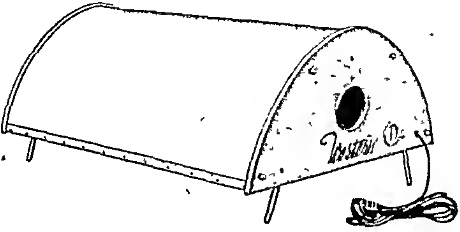


Photo Western Incubators Ltd, Chelmsford

FIG. 98.—ANOTHER TYPE OF ELECTRIC HOVER OF DISTINCTIVE DESIGN

Infra-red Ray Brooding. This method of brooding is of comparatively recent introduction; nevertheless, it has attained considerable popularity.

It is perhaps the most convenient of all systems of brooding, since the units can be used in houses and farm buildings of any type, provided they are well ventilated, free from draught and reasonably warm. Moreover, being small and so readily moved, the units can be taken from house to house as required.

Infra-red brooders are of two main types—the bright and dull emitter, the latter producing so-called black heat.

Bright emitters provide light as well as heat. They resemble large electric lamps with screw-in fittings. They are usually of 250 watts consuming about one unit of electricity every four

hours. They are available in white or red light, the latter cutting out glare, which some believe harmful because it is contended it makes the chicks restless and over-active. There is no evidence to support this contention. Red light tends to prevent cannibalism, but unfortunately cannot be relied upon to do so.

The lamps are mounted in metal reflectors. They are usually *suspended about 16 in. from the floor*, but in cold weather, especially if the house is not well insulated, it is wise

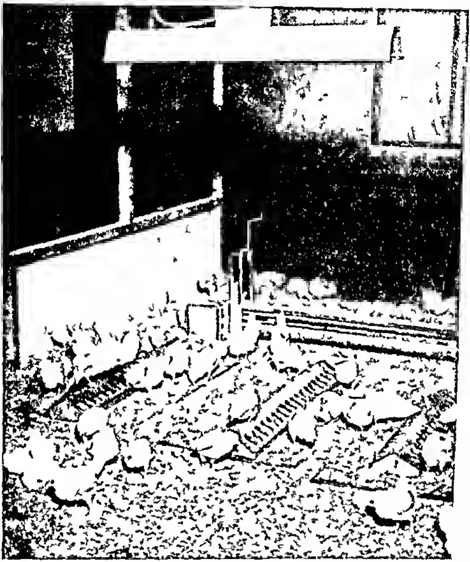


Photo Engelhard Industries Ltd Slough

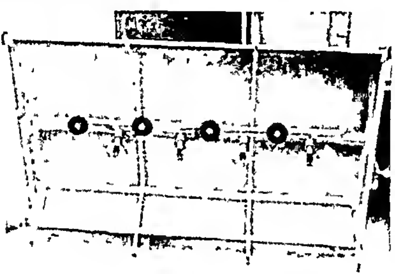
FIG 99A —A STRIP TYPE OF INFRA RED HEATER, "THE RADISIL" *HEATER WITH SILICA SHEATHED ELEMENT, WHICH GIVES HIGH* EMISSION OF SHORT INFRA RED RAYS

This unit provides a small amount of visible light giving a red-orange glow Heaters are available in 350 525 and 725 watts and are intended to operate at initial height of 2 ft 2 ft 9 in and 3 ft 6 in respectively

about 4 ft diameter will be sufficient for 100 chicks, 5 ft diameter for 250 chicks, the area being enlarged in the course of two or three days At a week old the chicks should have the run of the house or section as the case may be The strips should be about 18 in high

Food and water should not be placed directly under the lamps.

Dull-emitter units are also mounted in metal reflectors. A pilot light is useful, otherwise it is difficult to decide whether the power is on There is a wider variety of dull emitters than bright emitters. The former are broadly of three kinds—the cone type, similar to that used in the bowl type of domestic electric fire; the ring type, in which the heating element is



Many use a 400-watt heater for 120–150 chicks for the first two weeks or so, then replace it with one of 250 watts.

In summer a 250-watt heater will rear up to 150 chicks from the day-old stage. One must be guided by weather and housing conditions in matters of this kind.

Chick capacity of infra-red brooding units, however, depends

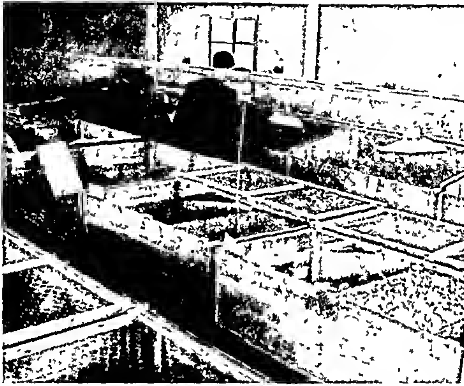


Photo Poultry Farmer and Packer

FIG. 101.—FIRST-STAGE BROODING IN 5-FT. × 5-FT. SECTIONS RAISED TO TABLE HEIGHT FROM THE FLOOR

The sections, which are held together with hook and eye fasteners, have boarded littered floors. Some sections are equipped with contact heat brooders, others with infra-red heaters.

more on the ambient temperature than is the case with warm-floor brooders or conventional hovers.

In a well-built but uninsulated house of timber construction it is advisable to reduce the above estimates by 15–20 per cent if the arrival of day-old chicks coincides with a spell of cold weather.

But the insulation of brooder houses is advised both for this and other methods of brooding.

Crooked Toe Deformity. Occasionally cases of crooked

toes occur among chicks reared under infra-red heaters, usually of the bright-emitter type. The fact that the appearance of the condition seemed to coincide with the introduction of this method of brooding led many to conclude that it was responsible for the deformity.

Black (1932) at Reading University showed that the suscepti-

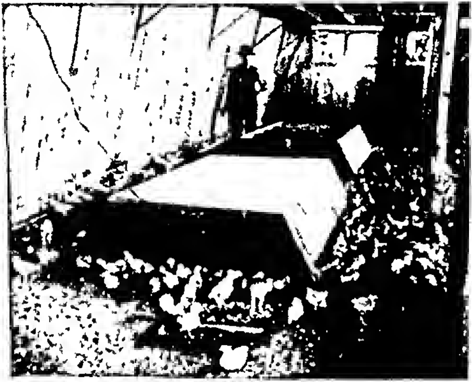


Photo: Poultry Farmer and Packer

FIG. 102. MULTIPLE-UNIT INFRA-RED BROODER IN USE IN A BROILER HOUSE

Each brooder is fitted with eight 250-watt heaters

bility to crooked toes is inherited by some strains, the deformity becoming manifest under certain environmental conditions. Infra-red brooding alone did not cause crooked toes.

The deformity is usually noticed when the chicks are three to four weeks old. The toes turn inwards. The deformity may be slight or severe. It does not appear to affect growth.

Hot-water Hovers. In the author's experience hot-water hovers are suitable only for the larger poultry farms on which floor brooding is practised.

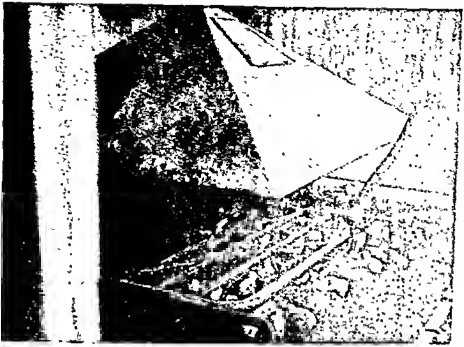


Photo: Modern Poultry Keeping

FIG. 102A.—A TYPE OF HOT-WATER HOVER

The canopy is suspended by ropes and the height is adjustable. Rubber piping enables the radiator to be moved aside when the house is cleaned. The canopy is raised to show radiator.

The capital outlay is considerable, and would not be justified unless a fairly large number of chicks is to be reared over a comparatively long season. These brooders require little attention beyond raking out the ashes and, in the absence of a

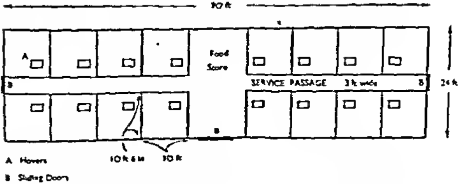


FIG. 103.—PLAN OF A BROODER HOUSE FOR FLOOR BROODING

Partitions should be portable. They should be constructed of light framing, the lower part boarded or covered with hardboard, the upper part should be of 1-in.-mesh wire netting.

mechanical stoker, making up the fires twice daily and even these chores, of course, are avoided by the installation of oil-fired boilers, which many large-scale rearers favour.

This method of brooding is now confined mainly to broiler plants.

The temperature is thermostatically controlled at the boiler,

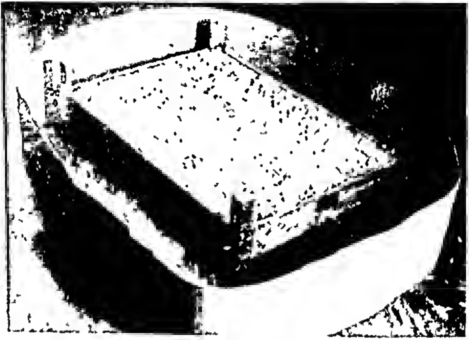


Photo: [illegible] Co. Ltd., [illegible]

FIG. 103A.—CONTACT-HEAT BROODER

A [illegible] contact heat brooder. The heating elements are between the plywood tops, well covered with litter to provide additional insulation, and rubber pad below. The height of the brooder is adjustable.

and, in addition, the heat may be reduced or cut off entirely in individual hovers by means of taps in the flow-pipes.

Several hovers are, of course, heated by one boiler placed in the centre or end of the house. The hovers consist of small horizontal radiators standing about 7 in. from the floor, with metal canopies above them. The canopies are adjustable, so that they can be raised or lowered according to the age of the chicks.

A hot-water-pipe system is employed on some farms. On this system the flow and return pipes run through the brooding

sections at a convenient height from the floor and in each section a box-like brooder is built over them.

Battery Brooders. The battery brooder as originally conceived consisted of a series of drawers superimposed, usually in four tiers. The brooder resembled a chest of drawers.

These brooders are usually of all-metal construction, and are heated by hot-water pipes, radiators or electricity.

Chicks in batches of about fifty per section are placed in the top drawers for the first fortnight, when they are moved to the lower drawers, where the temperature is somewhat lower. At

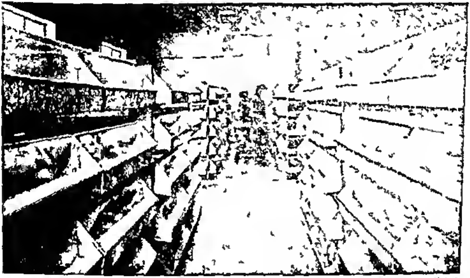


Photo N. W. Hempsall Ltd

FIG. 104.—FIVE-TIER WARM AIR BROODERS

Each block of brooders comprises five tiers on each side of a warm air duct. Air is heated by a boiler in an adjacent room and enters the warm section of each tier above the chicks. Chicks are reared to 14 days old, when they are taken to carry-on brooders.

about one month old they go into so-called carry-on batteries, or wire-floored cages without artificial heat.

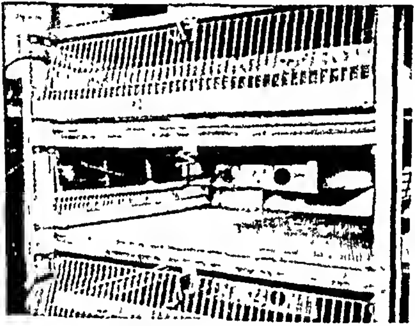
For the first stage the cages or drawers are usually about 18 in. wide—*i.e.*, from front to back—3 ft. long and 7 in. high; for the second—*i.e.*, the carry-on stage—the cages may be 3 ft. wide, 6 ft. long and 14 in. high.

Dimensions of the many brooders on the market are variable, and, of course, they differ in design, but the principle is the same in all of them.

Battery brooders enjoyed considerable popularity for a time,

and are to-day still favoured by some poultry-farmers, more especially by those who specialize in table-poultry (poussin) production or in the "started" chick trade, the chicks being sold when about a month old.

Battery brooders represent a very convenient system of rearing a large number of chicks in a small space. The chicks are under close observation, no litter is required, and it is unnecessary for the attendant to go down on his hands and knees when handling the birds or attending to the lamp.



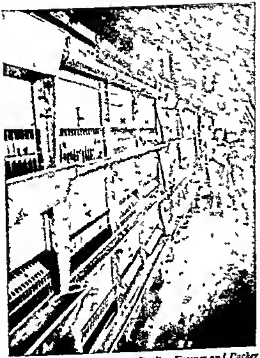


Photo Poultry Farmer and Packer

FIG. 106—ELECTRIC TIER BROODERS

Four-tier electric brooders with run extensions for growing chicks The tarred paper system of cleaning is employed, the paper being supported by ½-in mesh wire netting

weeks old, 20 sq. in. to four weeks, 50 sq. in. to six weeks, 65 sq. in. to eight weeks old, always assuming that adequate feeding space is available.

Tier Brooders. Tier brooders were developed from the battery brooder proper, and are designed to overcome the latter's most serious defect—that of keeping chicks confined to a heated compartment.

Tier brooders consist of a brooding section heated by oil, hot water, electricity or gas from main or cylinders.

In the oil-heated brooders heat is frequently supplied by small Putnam-type stoves which stand on a shelf under the wire floor. Two or more lamps may be employed during the first week of brooding, depending of course on the temperature of the house. In some brooders of this type flannel fitted loosely to a frame forms the canopy over the chicks.

In addition to the brooding section, tier brooders have a wire-floored run in which no heat is provided. Thus the chicks

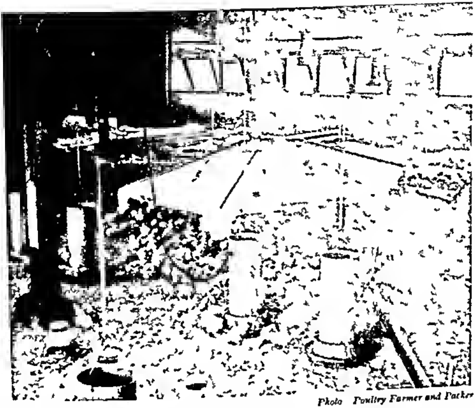


Photo Poultry Farmer and Packer

FIG 108 —A PROPANE-GAS-HEATED BROODER OF ABOUT 1,000 CHICK CAPACITY

Suspended from the roof, the height of the brooder is adjustable In this instance gas is stored in bulk supply containers outside the house The gas tubing is seen connected to the brooder

they provide floor space at the rate of about 12 sq in per chick, transferring the chicks to four-tier carry-on brooders for the fourteen- to twenty-eight-day period, allowing about 35 sq in. of floors pace per chick. At one month old the chicks are moved to hay-box carry-on brooders

Many criticize the tier brooder on the ground that the conditions under which the chicks are reared are too artificial,

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Photo: [illegible]

FIG. 107.—GAS HEATED TIER BROODERS, USED FOR REARING CHICKS TO FIVE WEEKS OLD

have the benefit of a run in cool air, which is very beneficial to them. They are livelier, better feathered and have keener appetites than when kept in a uniform temperature at all times.

Tier brooders offer all the advantages of the battery brooder and overcome one of its disadvantages—brooding in one temperature—but as with the battery, so with the tier brooder, the greatest care must be exercised to avoid over-crowding.

The majority of tier brooders are about 7 ft. × 3 ft. (overall), and are said to accommodate 100 chicks per tier. This is the day-old capacity, and if so many are put in at the outset the number must be reduced as they grow.

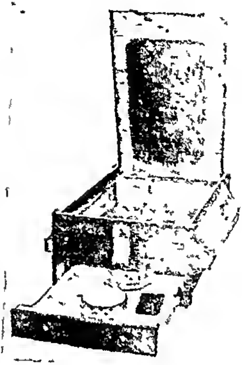


FIG 109 —A WARM-FLOOR BROODER

A popular type of warm floor brooder The top is raised to show the blanket canopy, wire floor and grille in front of the food trough

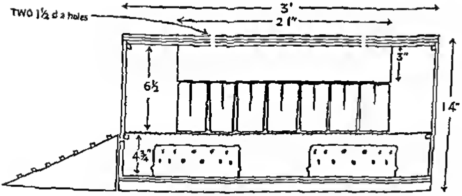


FIG 110 —A SECTION OF A WARM-FLOOR BROODER
Ventilation is usually controlled by a "hit and miss" device

that it produces what is so often termed the hot-house chick—a chick that lacks resistance to disease.

That will be so if the birds are overcrowded or the brooder not well housed, but there is no evidence that starting chicks in these brooders under good conditions has a detrimental effect on them.

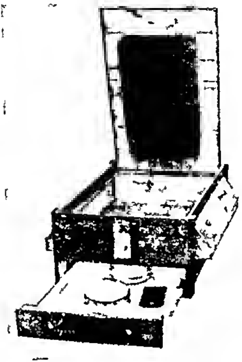
This system of brooding does not appeal to everyone, and the breeder must, of course, consider the wishes of his customers, even if he would prefer to use the system. Tier brooders, however, have been used with success for too many years on too many farms for any unprejudiced poultry-man to condemn them. They offer a convenient, hygienic, labour-saving method of rearing chicks for the first few weeks.

The tier brooder, like its prototype the battery brooder, must be properly housed. Many of the troubles attributed to these brooders arise not from any fault in their construction, but from faulty housing.

It should be clearly understood by all who contemplate installing these brooders that good housing is essential. They are not designed for use in draughty or stuffy buildings, or in places in which the temperature varies appreciably even in the course of twenty-four hours. On some farms where these brooders are used the temperature of the brooder-house is controlled by hot-water or electric heaters. Further, the house should be well lit, and sufficiently large to ensure comfortable working conditions.

Warm-floor Portable Brooders. This type of brooder has become very popular in recent years. It consists of an outer frame about 3 ft. × 2 ft. (for 100-day-old-chick capacity), with boarded sides and ends. Feed- and water-troughs are mounted on each side, the troughs fitted with glass panels to conserve heat. There is a pop-hole in one or both ends. The floor is of ½-in. wire mesh with blanket-type canopy over, and a drawer under the floor provides room for two or more heaters of the Putnam type or electric heating elements. A single thickness of hessian cloth is placed on the wire floor for the first five or six days.

When the chicks are between two and three weeks old the lid is raised slightly on turn buttons provided for the purpose, and a few days later the felt canopy can be removed. Lamps



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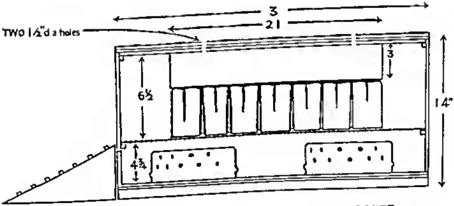

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When the chicks are between two and three weeks old the lid is raised slightly on turn buttons provided for the purpose, and a few days later the felt canopy can be removed. Lamps

The warming wire is continuous throughout the concrete block

Brooders constructed on the above lines are intended to take power during off-peak hours In normal c[illegible] house temperature of 60–70° F sufficient reserve of heat will be built up during the night to provide adequate brooding temperature at all times

Power is controlled by a time switch which is set to operate when power is available at off-peak rates

With this type of brooder canopies are not required Pilot lamps should be suspended over the heated blocks to attract the chicks These lamps should be run off a battery with trickle charger, so that they will remain on in the event of power failure.

Cost of materials for a heat-storage brooder about 6 ft × 6 ft is approximately £16

With power at less than *1d* per unit brooding cost on one large broiler plant worked out at about *½d* per chick for the full brooding period

Brooder-houses. All types of poultry houses have been pressed into service for brooding purposes with more or less success, but the commercial poultry-man will be well advised first to decide what system of rearing he will adopt, and then, if it requires a brooder-house, to select the most suitable type for the brooding system he favours

For range-rearing with portable hovers, a 6-ft × 4-ft house of simple design is commonly employed, but on the farm where chicks are reared throughout the winter it is desirable to have somewhat larger houses having a full span roof

In any event, the house should be portable, so that it can be moved to fresh ground from time to time While portability should be regarded as an essential feature, it should not be gained by sacrificing sound construction Very lightly built houses cause the rearer much anxiety in the winter months, on account of the difficulty of maintaining a reasonably constant temperature

A 6 ft × 4-ft house with a 150-chick hover will rear seventy to eighty chicks up to about six weeks of age, provided they have access to grass runs or sun balconies

Some use houses about 10 ft × 8 ft, fitting a temporary

are removed at intervals, usually between the third and fifth week, according to the weather.

In very cold weather it is usually necessary to use an additional lamp.

After a time the chicks have a run in the house or section thereof.

Warm-floor brooders for outdoor use are also available. These brooders, if used under fair conditions, are remarkably reliable. They are frequently described as the most fool-proof of all rearing appliances.

Some have extension units that can be fitted to the brooders when the chicks are about four weeks old, thus increasing the size of the brooder to take its full complement of chicks up to six or eight weeks old. This obviates the need for a carry-on brooder.

Heat-storage Brooders. Early attempts to rear chicks by heating the concrete floor of the house were not a success, probably because the system was applied in houses not well designed for this purpose.

To-day, however, heated-floor brooding is employed successfully on a number of farms, principally for rearing broiler chicks.

Electric heat-storage brooders are constructed for this purpose. The brooders may comprise concrete blocks about 6 ft. × 6 ft. × 1 ft. deep. The top of the concrete block is level with the floor.

A brooder of this size will rear about 1,000 chicks; two or more blocks are usually built in each house or section.

Alternatively, the brooder may comprise a continuous strip of concrete along almost the full length of the building.

Size and construction of the brooders are by no means standardized; but the underlying principle is common.

Pits about 1 ft. deep are made in the floor. They are lined with heat-insulating material, such as bonded Fibreglass.

Bottom of the pits is covered with about 3 in. concrete. Floor-warming nylon-insulated wires are laid on the concrete about 3 in. apart.

These wires are covered with about 6 in. concrete, and over this wires are similarly arranged. Finally, the top is finished with concrete to a depth of about 3 in. Top of brooder is lightly covered with litter.

The warming wire is continuous throughout the concrete block

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Some use houses about 10 ft × 8 ft, fitting a temporary

partition about 12 in high across one end to enclose an area of about 8 ft $\times$ 2 ft In this area a small brooder is arranged on the lines of the home-made brooder described on page 251 In due course the brooder is removed and a small slatted frame is placed over the area to provide a low roost Later perches or slatted roosts are fitted in the normal position for adult birds In this way the house is used for chicks, growers and adults, that is to say, the birds may be kept in the same house from day old until they are no longer required for egg production

Intensive Brooder-houses. Where the chicks are reared in total confinement on the floor, multiple unit-houses are advised They are without doubt the most suitable type of house for intensive rearing on a commercial scale Moreover, they are the most convenient for the attendant, and the human element should not be overlooked when considering matters of this kind The attendant is far more likely to make a success of his work if he can look after the chicks in comfort

On many holdings some of the buildings may be adapted for brooding purposes at little cost Stables, lofts and shedding of all kinds may provide excellent brooder accommodation, indeed conversion may entail no more than the installation of brooders and the erection of portable partitions Ventilation is likely to present the biggest problem Direct light is not, of course, essential If conversion of farm buildings is contemplated it is wise to seek expert advice. County Poultry Advisory Officers should be consulted

When, however, a brooder house is required it should be of efficient design and construction The difference between the cost of a really good house—a house built to an ideal—and one that is built to sell at the lowest possible price is not worth a moment's consideration When purchasing equipment of this kind it pays to buy the very best, for, although the capital cost is greater, it will earn bigger dividends over a greater number of years than the so-called "cheap" house Many poultry-farmers have lived to regret the day they tried to save a few pounds when buying their brooder-houses

Brooder houses for floor brooding should face south or south east if they are single fronted with a service passage at the back

Double fronted houses with central passage should run from north or south But the convenience of operation, levelness of

site and availability of water and electr... greater importance than aspect If poss l... should be avoided

The front of the house should be board... closed for the first 1 ft 6 in –2 ft from the floc... of the front being fitted with glazed shutters ... the chicks are to be reared in windowless houses

The house should be of the full-span type, not less than 12 ft wide, the length depending, of course, on the number of sections The height at eaves should be 6 ft, and at ridge not less than 8 ft 6 in

It should be constructed with $\frac{3}{4}$-in T and G weatherboards

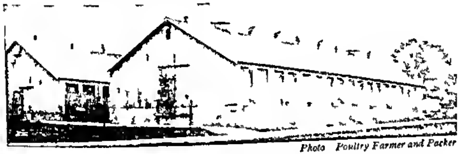

Photo Poultry Farmer and Packer

FIG 111 —INTENSIVE BROODER HOUSES
These 72 × 24 ft houses are used for rearing chicks to poussin weight The houses are equipped with four tier electric brooders

laid horizontally, the two ends, back and roof being lined with fibre boards, glass-wool, straw or hay held up by netting, or even paper meal bags Some of the softer boards, however, are liable to be damaged by the chicks pecking them Hard-board, three-ply or half inch matchboards should be used for the first 12 in from the floor

The cost of lining is fully justified, for two reasons—it prevents those sudden changes in temperature likely to occur during the night and that may result in the chicks being chilled, it conserves heat, and thus reduces the cost of running the brooders

Baffled and controlled ventilation should be provided, air entering the brooder sections at least 3 ft from the floor Inlets placed too low are liable to cause draught

Tobin tubes (see Fig 201) can be used to bring in the air at a suitable height and to control the rate of flow Some rely

partition about 12 in. high across one end to enclose an area of about 8 ft. × 2 ft. In this area a small brooder is arranged on the lines of the home-made brooder described on page 251. In due course the brooder is removed and a small slatted frame is placed over the area to provide a low roost. Later perches or slatted roosts are fitted in the normal position for adult birds. In this way the huuse is used for chicks, growers and adults, that is to say, the birds may be kept in the same house from day old until they are no longer required for egg production.

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On many holdings some of the buildings may be adapted for brooding purposes at little cost. Stables, lofts and shedding of all kinds may provide excellent brooder accommodation, indeed conversion may entail no more than the installation of brooders and the erection of portable partitions. Ventilation is likely to present the biggest problem. Direct light is not, of course, essential. If conversion of farm buildings is contemplated it is wise to seek expert advice. County Poultry Advisory Officers should be consulted.

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Brooder houses for floor brooding should face south or south-east if they are single fronted with a service passage at the back.

Double-fronted houses with central passage should run from north or south. But the convenience of operation, levelness of

site and availability of water and electricity services are of greater importance than aspect. If possible, exposed positions should be avoided.

The front of the house should be boarded up or otherwise closed for the first 1 ft. 6 in.–2 ft. from the floor, the remainder of the front being fitted with glazed shutters, unless, of course, the chicks are to be reared in windowless houses.

The house should be of the full-span type, not less than 12 ft. wide, the length depending, of course, on the number of sections. The height at eaves should be 6 ft., and at ridge not less than 8 ft. 6 in.

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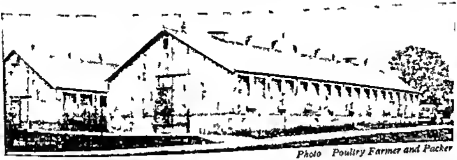

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Also, there are few things that cause him greater disappointment than a lot of chicks that fail to rear well.

Chick-rearing can be a real joy, but if for any reason it is not attended by success, then it is a most depressing experience. Not only is the knowledge of failure likely to have a bad effect on the poultry-man's attitude towards his stock, but unless he can solve his problem he will eventually be compelled to give up his farm, or at best will have to rely on purchasing growing stock.

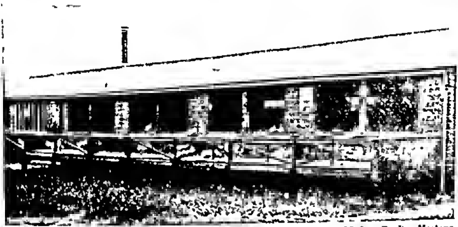

Photo Modern Poultry Keeping

FIG. 112.—AN INTENSIVE BROODER-HOUSE WITH SUN BALCONIES

Many poultry-farms have failed because their owners were unable to rear chicks successfully.

Chick Quality. Success depends on many factors, all of which are equally important because they are links in the rearing chain. Neglect of any one factor is sufficient to cause failure, and in practice it is commonly found that most of the troubles associated with this work are due to neglecting one or two apparently little things. In chick-rearing, as indeed in poultry management generally, everything affecting the well-being of the stock is important, however trivial it may appear.

The first essential in chick-rearing is to secure rearable chicks. This may seem to state the obvious; nevertheless, it is a fact that much of the mortality among young chicks is due to lack of stamina in the breeding-stock and to faulty incubation.

Strong, virile chicks cannot be produced from parent stock

entirely on windows for ventilation. They are satisfactory in the larger houses, but require careful adjustment. There should be efficient extraction in the ridge.

Floor ventilation in brooder-houses, especially where the chicks are reared on the floor, must be very carefully baffled and under the complete control of the attendant, or draughts will be created, and it is no exaggeration to say that it is better to provide no ventilation at this point than to set up draughts.

The service passage should be 2 ft. 6 in. wide. Each brooding section should be, say, 10 ft. × 9 ft. 6 in. (in a house 12 ft. wide), in which not more than 100 chicks could be reared up to seven or eight weeks of age. This should be regarded as the maximum number of chicks for a section of this size. In other words, a floor area equivalent to 1 sq. ft. per chick should be provided up to eight weeks of age, although ¾ sq. ft. per chick will be sufficient for the first six weeks. Overcrowding is the primary cause of trouble in chick-rearing, and must be avoided.

The capacity of brooder-houses may be increased by approximately one-third by the provision of sun balconies.

For battery or tier brooders the same general principles in the design of the house should be applied, with the exception that the front of the house should be boarded up for the first 3 ft. or 3 ft. 6 in. from the floor, and the house should be made double-fronted—*i.e.*, the front and back should be designed on similar lines. This will ensure more uniform distribution of light, and so prevent the chicks crowding at some of the food-hoppers while neglecting those in subdued light.

When rearing chicks on a commercial scale houses much wider than those formerly recommended are advised. Houses upwards of 24 ft. wide are not only cheaper per sq. ft. floor area but they also save much labour compared with those of 12–15 ft. width at one time regarded as ideal.

Artificial Methods of Rearing. Chicken-rearing by artificial methods is among the most important phases of the poultry-man's work. It is also the most interesting.

To the real poultry stockman—the man who keeps poultry because he likes them and not merely with the object of financial reward—there are few things from which he derives greater satisfaction than from rearing chicks of first-class quality.

Also, there are few things that cause him more disappointment than a lot of chicks that fail to rear well.

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Chick Quality Success depends on many factors, all of which are equally important because they are links in the rearing chain Neglect of any one factor is sufficient to cause failure, and in practice it is commonly found that most of the troubles associated with this work are due to neglecting one or two apparently little things In chick-rearing, as indeed in poultry management generally, everything affecting the well-being of the stock is important, however trivial it may appear

The first essential in chick-rearing is to secure rearable chicks This may seem to state the obvious, nevertheless, it is a fact that much of the mortality among young chicks is due to lack of stamina in the breeding-stock and to faulty incubation

Strong, virile chicks cannot be produced from parent stock

entirely on windows for ventilation. They are satisfactory in the larger houses, but require careful adjustment. There should be efficient extraction in the ridge.

Floor ventilation in brooder-houses, especially where the chicks are reared on the floor, must be very carefully baffled and under the complete control of the attendant, or draughts will be created, and it is no exaggeration to say that it is better to provide no ventilation at this point than to set up draughts.

The service passage should be 2 ft. 6 in. wide. Each brooding section should be, say, 10 ft. × 9 ft. 6 in. (in a house 12 ft. wide), in which not more than 100 chicks could be reared up to seven or eight weeks of age. This should be regarded as the maximum number of chicks for a section of this size. In other words, a floor area equivalent to 1 sq. ft. per chick should be provided up to eight weeks of age, although ¾ sq. ft. per chick will be sufficient for the first six weeks. Overcrowding is the primary cause of trouble in chick-rearing, and must be avoided.

The capacity of brooder-houses may be increased by approximately one-third by the provision of sun balconies.

For battery or tier brooders the same general principles in the design of the house should be applied, with the exception that the front of the house should be boarded up for the first 3 ft. or 3 ft. 6 in. from the floor, and the house should be made double-fronted—*i.e.*, the front and back should be designed on similar lines. This will ensure more uniform distribution of light, and so prevent the chicks crowding at some of the food-hoppers while neglecting those in subdued light.

When rearing chicks on a commercial scale houses much wider than those formerly recommended are advised. Houses upwards of 24 ft. wide are not only cheaper per sq. ft. floor area but they also save much labour compared with those of 12–15 ft. width at one time regarded as ideal.

Artificial Methods of Rearing. Chicken-rearing by artificial methods is among the most important phases of the poultry-man's work. It is also the most interesting.

To the real poultry stockman—the man who keeps poultry because he likes them and not merely with the object of financial reward—there are few things from which he derives greater satisfaction than from rearing chicks of first-class quality.

There are various litters suitable for baby chicks, choice depending largely on cost

The following are commonly used materials

Peat Moss This is a very popular litter, especially in districts where there is little arable land for the production of corn crops It is very absorbent, and an effective deodorizer, but rather expensive for chick-rearing, because in normal circumstances the chicks occupy the house only for a short period

Samples vary in quality granulated peat moss should be used A good sample is a light chestnut colour, and not unduly dusty Stringy or dusty samples are unsuitable for the purpose One 2 cwt bale will cover 300 sq ft to a depth of 1 in

Chopped Straw Where it can be obtained at an economic price, clean chopped straw cut in lengths of about 1 in can be recommended It is an excellent litter for the brooder-house The straw must have a clean, bright appearance and fresh smell Mouldy or musty samples must be avoided They may cause aspergillosis, a fatal respiratory disease of young chicks

Cut Hay This is not suitable material It is not absorbent, and soon becomes mouldy and matted with droppings Further, some of the chicks may eat it If consumed it may cause digestive troubles, such as impaction of crop and gizzard

Cavings Cavings are the glumes of the cereal grains separated in threshing They make a useful litter for chicks, but the material is light and easily blown about the brooder-house by slight wind

Cavings from barleys and bearded varieties of wheat should be avoided, as the sharp spines may injure the chick's feet.

Sand Sand is quite suitable for litter It is used on many farms, either alone or as a base over which lighter material is scattered It should be dried before use if damp

Cedar-wood Chippings This is a by-product from pencil factories It is a first-class litter, absorbent and deodorizing

that is constitutionally weak or temporarily debilitated. They cannot be produced from stock affected with Bacillary White Diarrhœa (B.W.D.) or from thin-shelled or stale eggs.

Chicks that are not well hatched are always difficult to rear. The vitality of many chicks is lowered by faulty incubation, often to so great an extent that their chance of survival in the brooder is remote.

It is unfortunate that these facts are not more widely recognized. Too often the brooder or the food is held responsible for heavy mortality when the real cause lies with the breeding-stock or the methods of incubation.

The chicken-rearer should be able to distinguish between a good chick and a bad one; he should be able to remove the weaklings *from a batch of day-old chicks; unless he can do this* he will never become a successful rearer.

The experienced rearer assesses the value of the chicks as they are removed from the incubator. He discards the weaklings at this stage: they do not get as far as the brooder. Good chicks have a characteristic "feel" about them when they are handled. Even at this early stage they express their strength and vitality. They kick vigorously, they carry plenty of flesh, they are the little balls of fluff that are the delight of every poultry-man. Moreover, the batch is uniform in quality: it does not include chicks that are obviously small and under weight compared with their companions.

A good chick should weigh from 1·4 oz., or about 8¾ lb. per 100; but no rearer would judge a sample on this basis. *He would be guided by their appearance and handling* qualities.

No chick having an improperly healed navel, small eyes, twisted neck or other serious physical defect should be *transferred* to the brooder. They are weaklings, and even if they survive for a time, they are susceptible to disease, and therefore a menace to the health of the entire batch.

Rigorous culling of day-old chicks is an essential part of the rearer's work. It is the first step to successful rearing.

Preparation of Brooder. Two or three days before the chicks are due to arrive the brooder should be prepared for them.

The appliance should be thoroughly cleaned and disinfected and, if it has a solid floor, littered.

There are various litters suitable for baby chicks, choice depending largely on cost

The following are commonly used materials

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Cut Hay This is not suitable material It is not absorbent, and soon becomes mouldy and matted with droppings Further, some of the chicks may eat it If consumed it may cause digestive troubles, such as impaction of crop and gizzard

Cavings Cavings are the glumes of the cereal grains separated in threshing They make a useful litter for chicks, but the material is light and easily blown about the brooder house by slight wind

Cavings from barleys and bearded varieties of wheat should be avoided, as the sharp spines may injure the chick s feet

Sand Sand is quite suitable for litter It is used on many farms either alone or as a base over which lighter material is scattered It should be dried before use if damp

Cedar wood Chippings This is a by product from pencil factories It is a first class litter, absorbent and deodorizing

Sawdust and Wood shavings Sawdust is a satisfactory litter for the initial brooding period when complete replacement of litter is practised for each batch of chicks. It is not very absorbent and, being of fine texture, tends to pack down.

Softwood shavings provide an excellent litter that can be used alone or mixed with other materials. Wood shavings are probably the most widely used of all litters, to the extent that in some districts demand exceeds local supply.

Coffee and Rice Husks Supplies of these materials are usually irregular. Like cavings they are light and their absorbent property is not high. They are occasionally used in the brooder house, although other litters are more suitable.

Dried Leaves Dried leaves are used occasionally, but they soon break up into powder, and need frequent replacement. The cost of collection and the necessity for storage do not seem to be justified.

Dried Soil Dried sifted soil may be used in brooders but cannot be recommended. The work of collection and drying is not worth while; moreover, there is some danger of introducing disease, especially if the soil is taken from land occupied or lately occupied by poultry.

Brooder Temperature For baby chicks the temperature of the conventional brooder should be 90–95° F. at a point midway between the lamp or other heater and the edge of the canopy and at floor level. It should be ensured that this temperature is not only attained, but maintained day and night before the chicks are placed in the brooder. If the heater will not provide sufficient heat without the assistance of the chicks or without having to cover the brooder with sacks, then it should be replaced by a better one.

The above mentioned temperature range, however, does not apply to contact heat or infra-red ray brooders.

Starting temperature on the floor in contact heat brooders is about 80° F. or about 87° F. at point of contact.

With infra-red brooding, floor temperature is not an accurate guide, because the value of these rays lies in their penetrative power, i.e. the heat provided within the chick's body.

Temperature on the litter immediately below a standard

infra-red unit 16 in. above it may exceed 100° F., or may be about 85° F. or less if the house temperature is below 60° F. Moreover, using a single unit, the area of heat is very restricted. A few inches away from the point below the unit the temperature falls rapidly.

The importance of having warm, well-built houses for this method of brooding will be recognized.

Although no statistics are available, probably more chicks die from chill as a result of lack of sufficient heat in the brooder than from any other cause.

The question of temperature is of the utmost importance. In no circumstances should an attempt be made to rear chicks in brooders that do not provide an ample reserve of heat that will allow for a drop in temperature in the early hours of the morning. It is at this time that so many chicks are chilled, and the origin of the trouble may be unsuspected, because the temperature of the brooder may be correct last thing at night and again when inspected in the morning.

The experienced poultry-man knows from the behaviour of the chicks whether or not they have been comfortable throughout the night. If they have been cold, there may be evidence of "sweating" (see *Ventilation* below), due to the chicks' crowding together to keep themselves warm, and they will lack the characteristic morning liveliness of well-brooded chicks. Chicks that have been cold are reluctant to leave the brooder; when they do they peck half-heartedly at the food and hasten back to the heat. Chicks that have been comfortable at night do not spend much time in the brooder. They are more interested in the food-trough, and if reared on a solid floor, in scratching among the litter.

The experienced rearer does not use a thermometer, except possibly to ascertain the temperature of the brooder before entrusting the chicks to its care.

When the chicks are in the brooder and have had time to settle down, even the novice will be well advised not to use a thermometer, which may prove very misleading. The behaviour of the chicks is the best indication of temperature. If they are cold they will huddle together in the warmest part of the brooder, and perhaps crowd into a corner in an endeavour to keep warm. If the temperature is too high they will spread

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With infra red brooding floor temperature is not an accurate guide, because the value of these rays lies in their penetrative power, i e the heat provided within the chick s body

Temperature on the litter immediately below a standard

atmosphere becomes heavily charged with moisture, condensation occurs and chicks kept under these conditions even for short periods have every appearance of having sweated

Poor ventilation will also cause damp litter This is a danger signal that no rearer can afford to ignore Should the litter be damp, he may be assured that the health of the chicks will suffer, and if the condition is not remedied, heavy losses must be anticipated Strong, healthy chicks cannot be reared on damp litter

Brooder Capacity It is customary for manufacturers to base the capacity of their brooders on the number of day-old chicks they will accommodate As some standard of comparison is desirable this is perhaps as good as any, provided the purchaser realizes what it implies It does not mean, for example, that a 100-chick brooder will rear this number of chicks up to six or eight weeks old

Chicks grow very rapidly, and it is obvious that if a brooder is filled to capacity or near capacity with day-old chicks they will be seriously overcrowded when a fortnight or so old Therefore it is wise, as a general rule, to reduce the capacity of brooders by at least 25 per cent if the chicks are to be reared in them for the first month, 50 per cent if they are to be reared for the full brooding period of six to eight weeks Many modern brooders, however, provide so much heat that the chicks spread in a wide circle, even day-olds settling down outside the perimeter of the canopy Brooders of this type will usually rear the stated number of day old chicks to the normal weaning age

Some makers of other types of brooder, *e g*, tier brooders, now give the actual rearing capacity of their appliances, although many are a little optimistic in their estimates

At this point it will be convenient to discuss the size of the brood when rearing by artificial methods Following the introduction of mass rearing methods for table poultry (broiler) production, there has been a tendency towards larger units when rearing pullets intended for the laying-houses and breeding-pens On some farms pullets are brooded in extremely large lots, indeed broiler methods are applied

Theoretically, of course, the larger the brood, the more economically the chicks are reared, because the cost per chick

themselves well away from the heat, and in extreme instances droop their wings and gasp.

Chicks should settle down in a ring about half way between the heater and the edge of the canopy. Then we know that they are comfortable, and can move nearer to heat should they feel cold in the early hours of the day.

An abundance of heat is necessary, however, both night and day, because when chicks are running about they must be able to warm up quickly when they return to the brooder.

In ordinary circumstances there is little danger of over-heating; there is none if the chicks are able to move away from the heat should it prove too much for them. Where they are closely confined to the *brooding compartment*, as in some *foster mothers*, this danger must be guarded against, for a high temperature is fatal.

The upper limit of heat that baby chicks can tolerate appears to be doubtful, but it is probably well over 110° F. However, the question is of little practical importance, because the rearer would at once take steps to reduce the temperature should there be evidence of over heating.

Ventilation. Efficient ventilation of the brooder-house and the brooder is essential. In the brooder house ventilation should be under the control of the attendant. It should be adjusted to suit prevailing weather conditions.

In the brooder itself there must be a steady flow of fresh air without perceptible draught.

Wire floors are of great assistance in improving ventilation but before using them for baby chicks it should be seen that the correct temperature can be maintained. Covering the wire floor with a single thickness of hessian cloth for the first week *will often solve the heating problem*.

If the chicks are exposed to draught they will crowd to one side of the brooder. If they have insufficient fresh air, they soon become debilitated. They have an anæmic appearance, the feathering is loose and often the chicks show signs of having "sweated"—that is to say, the feathering is damp and more or less bedraggled.

Chicks do not sweat; they have no sweat glands. When the poultry man speaks of his chicks sweating he really means that the ventilation is so poor in the brooder that the

the hover until they are familiar with their surroundings and know their way back to the heat.

A guard of cardboard or wood—four boards held together with hook-and-eye fasteners will serve the purpose very well—will also act as a draught-screen.

A guard should also be placed across tier brooders about 6 in. from the heated section.

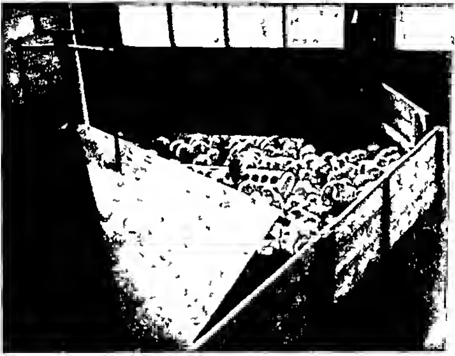

Photo Modern Poultry Keeping

FIG 113 —BOARDS ARE USED TO KEEP THE CHICKS NEAR THE HOVER FOR THE FIRST FEW DAYS

Later they are removed and the chicks have the run of the section of the house

Feeding the Chicks. Food and water should be available when the chicks are placed in the brooder. At one time it was believed that starving them for about forty-eight hours hastened the absorption of the yolk, which is drawn into the chick's abdomen immediately preceding hatching. Experiments by Parker, however, have shown that this is not so; on the contrary, far from hastening yolk absorption, starvation actually delays it. There is no object in withholding food when the chicks are hungry, and if food and water are available immediately there is no serious risk of the hungry chicks eating litter.

of labour, litter, heating and other items is reduced proportionately as the unit size is increased. This also applies in practice to table poultry, but table birds have a short life.

Pullets are a different proposition. They have to stand the strain of egg production, and many are used for breeding purposes.

In view of present knowledge, particularly with regard to fowl paralysis and leucosis, it is wise to rear this class of stock in comparatively small groups. It is suggested that 300 chicks per group should be regarded as the upper limit. As a rule, better results will be obtained if the number does not exceed 200.

There is an apparent correlation between density of poultry population and the incidence of fowl paralysis and leucosis.

Cottral (1952) suggested that the high incidence is related to the nature of the disease and the conditions under which the chicks are raised. He pointed out that leucosis was more prevalent in countries in which there had been a rapid expansion of the poultry industry, with the adoption of mass-production methods.

Brooding—The First Week. Chicks should be removed from the incubator to the brooder in flannel-lined baskets or boxes lined with hay. The change should be made without undue delay, for although chicks travel long distances when packed in well-designed boxes, they are easily chilled on the farm.

When they are reared in hovers on the floor it is advisable to stand the hover on a small wooden floor extending about 6 in. from the outer edge of the canopy, or on a metal or hardboard sheet, because when the hover is placed directly on the floor of the house the heat may so contract the floorboards that draughts may arise from cracks between them. Some rearers use a square of cheap linoleum under the hover.

When the chicks are placed under the canopy, the hover should be surrounded by a guard 9 in. deep, standing some 12 in. from the canopy. Small-mesh wire netting is commonly used for this purpose, but a more effective guard may be made with lengths of stout cardboard glued together to form a strip. This is placed around the hover, the two ends of the strip being held together with a clothes-peg.

The object of the guard is to prevent the chicks straying from

the hover until they are familiar with their surroundings and know their way back to the heat.

A guard of cardboard or wood—four boards held together with hook-and-eye fasteners will serve the purpose very well—will also act as a draught-screen.

A guard should also be placed across tier brooders about 6 in. from the heated section.

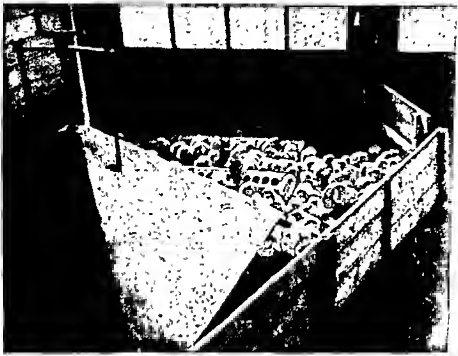

Photo: Modern Poultry Keeping

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The guard facing the windows should be extended to provide room for the food and water troughs and to give the chicks a small playground. This area should be extended daily for the first week; thereafter the guard can be removed altogether and the chicks permitted to occupy the entire house or section of it.

The dry-mash (or pellet) system of feeding is recommended. It is clean, labour-saving and less likely to cause digestive trouble than wet mash feeding.

Whether grain should be fed in conjunction with mash is purely a matter of opinion. A vast number of experiments have been carried out in different systems of feeding; none has shown any significant difference between all-mash and mash-and-grain feeding provided the diet is adequate in quality and quantity. Where grain is fed, the mash should supply those food constituents in which grain is deficient.

The majority of proprietary chick-mashes and pellets or chick "crumbs" are intended to be fed without grain, and if the latter is given it will have the effect of diluting the mash or pellets. With chicks reared extensively on range of good quality this may merely result in slowing down the rate of growth, but when they are reared in confinement or under conditions where they cannot supplement their diet, grain-feeding may so unbalance the ration as to cause a deficiency of one or more essential factors.

Pellet-feeding enables the chicks to fill their crops quickly, then the birds tend to stand about if they are reared intensively. As a consequence all pellet-feeding may encourage feather-plucking.

Grit for Chicks. Two types of grit are normally employed in poultry feeding. They are:—

(1) Insoluble grit, which assists the grinding action of the gizzard. Flint and granite grit are commonly used for this purpose.

(2) Soluble grit, which is provided as a source of supplementary calcium. Soluble grits include limestone, oystershell and cockle shell.

Unless the chicks are fed grain or are on grass range, they do not necessarily require insoluble grit, but a limited quantity

may aid digestion and assist gizzard development For this reason the majority of rearers supply it for pullets

In table production there appears to be no advantage in supplying insoluble grit unless the birds have grain in addition to mash

In a study of the evaluation of insoluble grit for table chicks (broilers), Combs, *et al* (1954) found that insoluble grit was desirable only when corn was fed as part of the ration When an all-mash diet was fed differences in growth rate and feed efficiency were extremely small and of doubtful significance The increased return over feed costs was not sufficient to defray the cost of the grit When grain is fed it was concluded that the feeding of insoluble grit was economically sound

Insoluble grit may be fed *ad lib*, *i e*, it may be given in a separate container Some objection is taken to this on the ground that an excess may be consumed, but in the writer's experience healthy birds, kept under favourable conditions and fed balanced diets, will not eat an excess They may do so if the diet is inadequate, if conditions are unfavourable or if affected with disease, *e g*, worm infestation or irritation or inflammation of the digestive tract In these circumstances insoluble grit may cause laceration of the intestines because the excess passes out of the gizzard

In fact, very little insoluble grit is required at any time, and when not offered *ad lib* it is sufficient to scatter a little in the litter or in the feed troughs at monthly intervals Fine grade should be used for chicks

With calcium grit it should be realized that diets made up to conform to modern standards provide sufficient calcium, therefore no useful purpose will be served by supplying calcium grit On the contrary, it may do more harm than good by creating an alkaline condition of the digestive tract Too much calcium will cause indigestion, the symptoms being retarded growth, loss of weight and the appearance of undigested food in the droppings

When feeding completely balanced diets calcium grit should not be provided until the birds are starting to lay If home-mixed mashes are used which are deficient in calcium, calcium grit should be available in a separate container

The lamps of oil-heated brooders should receive daily

attention, the wicks being trimmed by removal of carbon deposit. This should be done with finger and thumb. The wick should not be cut. The oil should be replenished every day unless the container will hold sufficient to last for a longer period.

This work should be done in the morning or early afternoon, so that the lamp can be properly adjusted before nightfall. There is, of course, a tendency for the lamp-flame to rise after refilling, and for this reason it is most undesirable to make adjustments late in the day.

The oil container should not be completely filled, for it is essential to allow room for expansion as the oil is warmed. Many disastrous brooder-fires are caused by over-filling the lamps.

The chicks should always be visited the last thing at night. This final inspection is an important one. They should be sitting about comfortably, and should make little noise except for an occasional " cheep ".

If they are bunched together and cheep despondently when disturbed, they are too cold; if crowded to one side of the brooder, draughts are responsible; while if they spread themselves far away from the heat, obviously it is too much for them.

Where hover curtains are used it should be seen that they do not actually touch the litter. This provides better ventilation, and avoids the danger of the litter being piled up against the curtains, thus preventing the chicks moving away if the temperature is too high.

One should always look under the brooders the first thing in the morning. Some of the chicks may have died in the night. The condition of the litter should be noted, and it should be replaced if damp, but it should not be damp if the brooder is well ventilated and the chicks are healthy.

Brooding from the Second Week. At one week old the chicks should be strong on the leg and able to look after themselves to a very great extent. If they are reared on littered floors, the feeding-troughs and drinking-vessels should be raised on low platforms, preferably with wire floors, with ramps, so that they can easily run up to the food and water. Unless this is done, the troughs will be contaminated with litter and droppings, and, as a consequence, the danger of spreading disease will be greater.

Food-troughs. Great care should be exercised in the choice of feeding-troughs, for chicks delight in climbing over them, and if possible they will get into them and scratch among the food, fouling it with their droppings. Troughs should always, as far as possible, prevent contamination and waste.

A trough with stout wires forming a grill set at a sharp angle is quite effective, as is one with a revolving bar running down the centre over the open trough. The chicks cannot perch on this bar, which is so placed that it prevents their getting into the trough, although it does not, or should not, make the food less accessible.

Tubular feeders or open troughs with a lip to prevent chicks pecking out the mash are recommended. They are more efficient than many of the so-called self-feed type with hoppers that are constantly clogging.

For the first few days the food may be given on strips of cardboard—some use the top of day-old chick boxes, others Keyes egg-trays.

Tubular feeders are suitable for baby chicks, growing and adult stock, since these feeders are suspended from the roof. The height from the floor is readily adjusted as the chicks grow.

Feeding-space. Uneven growth and cannibalism commonly arise from failure to provide sufficient feeding-space. This naturally results in crowding around the hoppers; the less assertive chicks are unable to have their fair share of the food, and in the struggle to reach the troughs those at the back often peck the chicks that are feeding. So troubles begin.

Suggested feeding space requirements per 100 birds are given in Table 23.

TABLE 23

Feeding Space per 100 Birds

Age	Dry mash	Wet mash
Day-old to 2 weeks	8 ft	10 ft
2–4 weeks	12 ft	15 ft
4–8 weeks	20 ft	24 ft
8–12 weeks	24 ft	34 ft
12–18 weeks	30 ft	40 ft
From 18 weeks	40 ft	50 ft

The allowances refer to total feeding space. If double-sided feeders are used half the above-mentioned length of trough will be adequate.

In open troughs the feed level should be kept low—about 50 per cent of capacity. This will reduce waste. When tubular feeders (hanging) are used it is usual to provide one (about 35 lb. capacity) per forty-five chicks, thirty growing birds or twenty-five adults. If chicks are fed once daily smaller feeders of about 16 lb. capacity will be adequate.

For the first few weeks of rearing comparatively small amounts of food should be put in the feeders. Even when feeding adult birds the amount of food in the tube part of the feeder should not exceed about two-thirds of its capacity.

Less feeding space is needed with feeders of this type because more birds can feed at the same time than from long troughs. Multiplicity of feeders also diminishes bullying.

It is much more satisfactory to use two or three small feeders in preference to a single large one. Then they can be placed in different parts of the run, and so divide the chicks, thus reducing interference while feeding. Moreover, long troughs are cumbersome for the attendant to handle, especially if he is rearing in confinement. Many windows have been broken when using long feeders in the houses. Length should not exceed 6 ft.

Water Consumption. Total water consumption is about twice the dry weight of the food consumed. This is a fair basis on which to calculate the water requirements of different classes of poultry. During the first two weeks after hatching 100 chicks will drink about 1 gallon of water daily; from $1\frac{1}{2}$ to 2 gallons to six weeks of age, 3 gallons to ten weeks; 3 gallons to twenty weeks, thereafter from 4 to 6 gallons daily. More water will be consumed in hot weather than in cold. Birds fed dry mash will take more water from the troughs than those fed wet mash, birds having fresh green will take less than those without it.

Water consumption will be higher than normal if the birds are kept in overheated brooders or houses, or if the diet contains an excess of common salt.

It is important to provide ample water-trough space. Recommended allowances are frequently inadequate. One quart-

capacity conical-type drinker or its equivalent is required per 100 chicks for the first week, one 2-gallon drinker for chicks up to about six weeks old, thereafter a 1-ft. double-sided trough.

When the chicks are about two to four weeks old many poultry-keepers use automatic drinkers.

After the brooder stage it is wise to provide trough space

Photo: Modern Poultry Keeping

FIG. 114.—A BROOD OF CHICKS

The hover curtain has been removed.

equal to that recommended for adults, *i.e.*, one 2-ft. double-sided trough per 100 birds or a 10-in.-diameter bowl for 150. One cup-type drinker will be sufficient for fifty birds.

Chicks should not be compelled to walk more than about 15 ft. to water.

Reduction of Temperature. As the chicks grow the temperature should be gradually reduced until they are weaned at six to eight weeks old, according to the time of the year and weather conditions.

For many years it was customary to advise a reduction of about 5° F. per week, down to about 70° F. at the end of the fourth or fifth week.

It is not wise to follow an arbitrary rule of this kind. It is far better to provide an abundance of heat and allow the chicks to settle down where they are comfortable, even if some of them spread outside the hover canopy. In hovers with

curtains, instead of reducing the heat at its source, it is wiser to tuck up first the outer row of curtains and later the inner row.

One should always be guided by the behaviour of the chicks. The poultry-man who studies the thermometer instead of the chicks will never make a successful rearer.

Extensive Rearing. Where extensive methods are practised

Photo: Poultry Farmer and Fancier

FIG. 115.—RANGE REARING PEDIGREE CHICKS.

Portable 6-ft. × 6-ft. houses with 9-ft. × 6-ft. runs attached used for rearing chicks from about three to nine weeks old, when they are moved to larger shelters. The houses are equipped with carry-on hovers heated with hurricane lamps.

the chicks are usually given a small grass run when they are a few days old. *Weather conditions must be the determining factor. It is folly to compel unfledged chicks to go outside* when cold winds or rain prevail. Such procedure may result in the survival of the fittest. It certainly kills the weaklings, but it also undermines the constitution of the strongest chicks.

Exposing young chicks to cold winds and rain is not adopting Nature's methods, as some would have us believe. In a state of Nature, chicks are not hatched in the winter, and the poultry-man cannot afford to wait until the natural hatching season if he is keeping poultry for a living.

Chicks should not be given range at a certain age, but when the weather is favourable. Cold alone will not harm them, provided they know their way back to the warmth; but cold winds and heavy rain will soon chill them, resulting in heavy mortality. A high proportion of the survivors, also, will not prove profitable.

Chicks must be under control when outside. The runs should be comparatively small, and the lower part of the

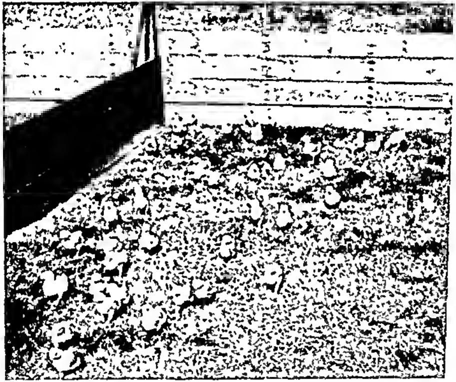

Photo: Modern Poultry Keeping

FIG. 116.—BABY CHICKS ON GRASS RANGE

This picture shows the keen, alert appearance so typical of healthy chicks.

fencing should be boarded up, or fitted with galvanized metal sheets to give protection from wind.

On the first few occasions when they are given a run it should be of short duration, and the attendant should stand by in readiness to drive them into the house when they have had a few minutes outside. This should be done until he is assured that they know their way back.

Care should be taken to provide a suitable run-up to the pop-hole. A single board is not satisfactory, because the chicks

may congregate under it, and so get chilled. A three-sided ramp is preferable, or even pieces of turf.

Later in the season it is essential to provide the chicks with shade. While reasonable exposure to sunshine is very beneficial, one can easily give chicks too much of a good thing. Undue exposure to the blazing heat of the sun is very injurious. It retards growth, causes loss of condition, and consequently lowers the bird's resistance to disease.

No difficulty will be experienced in providing shade. A

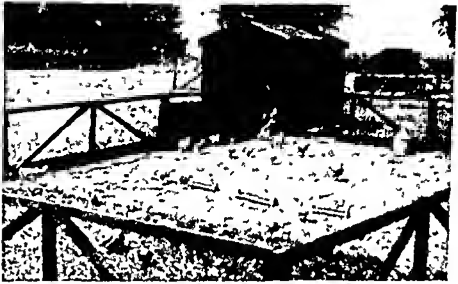

Photo: Modern Poultry Keeping

FIG. 117.—HURDLES ARE A VERY CONVENIENT FORM OF FENCING WHERE CHICKS ARE REARED ON RANGE

This run has just been extended. Note how the chicks have eaten down the grass in the run.

few sacks attached to the wire netting or to stakes driven in the ground will usually be sufficient for the purpose, or a light framing may be covered with sacks or short branches of trees. Wattle hurdles are used on a number of farms, both for protection against winter winds and summer sun.

Renewing the Litter. For many years the renewal of the litter at frequent intervals was recommended largely as a means of preventing outbreaks of coccidiosis. In view of present knowledge, however, this course is no longer advocated. On the contrary, provided the litter keeps dry and is raked over

occasionally, in normal circumstances it should remain in the house for the full brooding period. Some put a new batch of chicks on old litter after it has been heaped up and allowed to heat, but the writer does not favour this procedure when rearing pullets.

Nevertheless, the deep or built-up litter principle can be applied with advantage to chick-rearing, even though fresh litter is used for each batch of chicks.

It saves labour, but of even greater importance, it gives the chicks an opportunity of coming into contact with certain

Photo Modern Poultry Keeping

FIG. 118.—DULL EYES, DROOPING WINGS AND LOOSE FEATHERING SHOW THAT THESE CHICKS HAVE RECEIVED A CHECK

These symptoms are commonly associated with coccidiosis or a chill

diseases likely to be present in greater or lesser degree when they go on range. Thus they are able to build up their resistance. In other words, the deeper-litter system tends to provide a sub-lethal dose of disease.

Sanitary measures in chick rearing can be carried too far. If the chicks are protected from all infection, heavy mortality may occur when they are moved to a normal environment. Coccidiosis is an excellent example of the value of sub-lethal doses of pathogenic organisms. Built-up litter also furnishes vitamin B_{12} and its associated factors.

It should be emphasized, however, that the proper application of the system is essential. The litter should be built up in accordance with modern practice and it must remain dry.

If it becomes a soggy mass then the condition is likely to result in a serious epidemic of coccidiosis and probably colds.

Throughout the brooding period the chicks should be kept under close observation. They should be carefully inspected every day. Chicks that are weakly should be destroyed; indeed, efficient culling is one of the most important phases of this work. There is much truth in the adage that "a good rearer must be a good killer". He will not be a good rearer if he allows sentiment to interfere with his judgment of chick quality.

The weakly chick is easily recognized. It has a sad expression, its wings droop, and it spends most of its time in the warmth of the brooder. A chick of this type should be killed at once. It will rarely reach maturity, or if it survives it will not be profitable.

As the chicks grow larger feeding-troughs should be provided, care being taken to use troughs of efficient design. The temperature of the brooder should be progressively reduced until at about six weeks of age the chicks have no artificial heat.

Weaning the Chicks. Actual weaning-time depends not only on weather conditions, but also on the type of house employed for the growing stage. If the chicks are to be transferred from the brooder-house to night arks, it is advisable to use the brooder without artificial heat for a week before moving them, and it is always wiser to delay the move for a week or two rather than risk chilling the young birds.

On the other hand, if they are to be housed in solid-floor houses they may be moved at an earlier age.

Carry-on Brooders. On a large number of farms the chicks do not occupy the brooders for the full brooding period; instead they are moved to carry-on brooders at three to four weeks old. This procedure has the effect of doubling the capacity of the brooder-house. Moreover, carry-on brooders often provide more suitable conditions for chicks of this age than those used for younger birds. They have more fresh air and elbow room.

Carry-on brooders consist of a metal canopy with hurricane lamp beneath. Some rearers suspend the canopy from the roof of the house, and after the chicks have been in the house for a week raise it well clear of the floor during the day.

Others use a metal or wooden canopy with a blanket of flannel beneath fixed so that it just touches the bird's back

Curtains are not usually fitted to this type of brooder. If they are, they should be tucked up after the first week.

Where a small laying-house or section thereof is available a temporary carry-on brooder may be made by attaching sacks to the edge of the dropping-boards and suspending a hurricane lamp below the latter. A slatted or wire floor should be used in the brooding-section.

When rearing in battery or tier brooders it is customary to move the chicks when three or four weeks old to carry-on cages or hay-box brooders.

Carry-on, or cooler cages, as they are often called, are usually of metal construction with welded or woven mesh floors. They are commonly built in four tiers.

No artificial heat is provided in the cages, but they should be housed in well-insulated buildings. On some farms the carry-on brooder rooms are equipped with space heaters which are switched on during severe weather.

Hay-box Carry-on Brooders. In recent times carry-on brooders employing the hay-box principle have become very popular, and they are now in use on farms in all parts of the country. Since no artificial heat is provided, there is no risk of fire, and they effect great economy in labour.

The hay box, for forty to fifty chicks, is usually about 36 in. square, 14 in. high, with the corners rounded off with a metal or hardboard strip 9 in. wide. The floor is of $\frac{3}{4}$-in.-mesh wire supported by battens. Battens are also fitted over the metal or hardboard strips, and on them is placed a hessian bag lightly stuffed with hay. The hay-bag canopy is usually 9–10 in. from the wire floor. The latter is about 3 in. from the ground. Some prefer to cover the batten frame with hessian and place loose hay on top rather than bags of hay. The amount of hay can thus be regulated more precisely, and weaning is more progressive and gradual. Others use paper meal bags without hay.

No specific provision is made for ventilation beneath the wire floor, since the normal unevenness of the ground ensures sufficient circulation of air.

The brooders have ventilation in the gable-ends effected by a few $\frac{3}{4}$-in.-diameter holes or a triangular aperture about 3 in. × $\frac{3}{4}$ in. to apex. The run attached to the hay-box

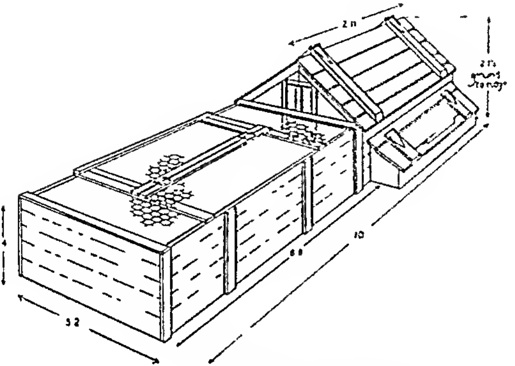

FIG 119 — A TYPE OF FOLD UNIT HOUSING THE HAY-BOX CARRY-ON BROODER

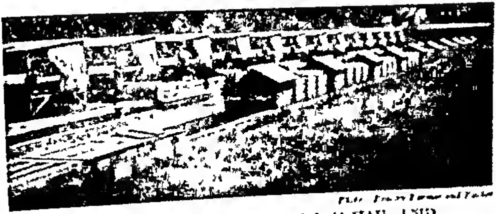

Photo [illegible]

FIG. 120 — HAY-BOX BROODERS IN USE AT STATE [illegible] [illegible]
They are placed on concrete [illegible] [illegible]
on rearing units are in the [illegible]

section is usually about 6 ft × 3 ft, the whole forming a fold unit about 9 ft × 3 ft

Some hay-box brooders have no built-in food troughs either in the brooder or run section A 3-ft trough may be placed along one side of the hay-box, but clearly the feeding space is inadequate for forty to fifty chicks Hay-boxes with additional troughs fitted on the outside principle on one side of the run are preferable

Brooders should be moved to fresh ground daily The grass must be kept short Chicks are taken to the brooders when three to four weeks old The hay-bags are usually removed in the course of about a fortnight, but this will depend on the weather.

In normal circumstances the wire floor should not be covered with litter even when the chicks are taken to the brooders in cold weather If the ground is very uneven and the weather severe it may be desirable to use a little straw on the floor for a time.

Where economy of rearing ground must be considered, hay-box brooders may be used as static units For this purpose they may be raised to table height, preferably over a concrete yard, the run section being fitted with a wire floor suitably supported to prevent sagging In this case the brooder floor should be littered for the first few days More commonly, however, when so used, the units are placed on low walls of concrete or brick which provide a droppings pit Walls are usually about 12–18 in high, and since they effectively baffle floor ventilation, it is unnecessary in normal circumstances to litter the brooder floor.

When the chicks are about eight to nine weeks old they are taken from hay-boxes to arks, range shelters or solid-floor houses

The hay-box proper may be used indoors, the chicks having access to a section of the house When so used the vertical battens of the corner framing should be extended ¾ in to raise the brooder from the floor and thus provide ventilation

Hay-box Rearing Units As hay-box brooders cost about £10–£11, they represent much idle capital if the rearing season is a short one In order to effect economy in housing, brooders that can be readily converted into rearing arks are available.

It is impossible to describe the different convertible brooders, but the same general principle is common to all.

One consists of a 10-ft. × 3-ft. fold, 2 ft. 3½ in. to eaves. It has a sliding, curved roof of resin-bonded plywood. The first section, with temporary partition, comprises the hay-box,

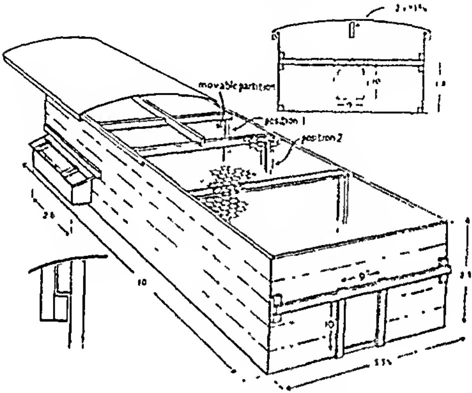

FIG. 120(a).—HAY-BOX REARING UNIT

This hay-box rearing unit with its removable fittings and partition will house chicks from 3–4 weeks of age to point of lay

the centre section, a covered slatted floor run and the third section an open grass run.

When the chicks are seven to eight weeks old, the hay-box fittings are removed, the wire floor replaced by a slatted floor and the partition moved to the end of the central section, thus doubling the roost area. At this stage the pop-hole in the run is opened to give the growers free range. Later the partition at the end of the slatted-floor section can be removed.

When chicks are taken from the brooder or carry-on brooder to a house with a solid floor, slatted or wire frames should be

Table 24

Average Live-weight of Poultry at Different Ages
Data from National Institute of Poultry Husbandry (1956)

Age in weeks	Light × Heavy (W.L. × B.R.) Male		Female		Heavy × Heavy (Tav.S × Sussex) English ration Male		Female		Broilers (Tav.S × Sussex) U.S.A. ration Male,		Female.		Capons (I.G.S. × Sussex) Surgical	
	lb	oz.	lb	oz	lb	oz	lb	oz	lb	oz.	lb	oz	lb	oz
4						10		9		13		12		
8	2	0	1	11	2	0	1	11	2	10	2	3	1	7
12	3	10			3	11	2	14	4	10	3	8		
20			4	9										
24														
28–30													8	2

Cumulative Food Consumption

					Mixed sexes		Mixed sexes			
	lb	oz	lb	oz	lb	oz	lb	oz	lb	oz
4					1	8	1	9		
8	5	7	5	3	5	12	6	5	4	6
12	13	4			12	12	13	5		
20			26	13						
24										
28–30									61	0

Table 25

Feed Required and Time Required to Obtain Certain Average Live-weights with Common Breeds of Chicken (Data from Publication 827, National Research Council, Washington, D.C., 1960)

Average live-weight	[illegible] White Leghorns Females	Males	Heavy breeds Females	Males	[illegible] White Leghorns Females	Males	Heavy breeds Females	Males
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

difference between breeds in the early stages It also varies with the strain, but the greatest factor of all is the food, its composition, physical condition and palatability, assuming, of course, that environmental conditions do not retard the chick's development

Each of these factors has a marked effect on growth, and will be discussed in the chapter on feeding

Table 24 shows average live-weights of different classes of stock at specified ages obtained at the National Institute of Poultry Husbandry (1956)

Table 25 shows the approximate weight of food consumed and time required to obtain certain average live-weights

Lippincott suggests an easily remembered scale which for light breeds is sufficiently accurate for practical purposes This gives the food consumption for 100 chicks as 10 lb during the first week, 20 lb during the second, 30 lb during the third and so on up to 100 lb during the tenth week, when an extra 5 lb of food per week should be added for each 100 chicks up to twenty-four weeks

His table is on p 306

In round figures it can be reckoned that 100 heavy breed chicks will consume about 1½ cwt of food in the first month, 3½ cwt in the second, 5 cwt in the third, 6½ cwt in the fourth and 7½ cwt in the fifth month, a total of 24 cwt

A pullet will consume 25–30 lb of food from day old to point of lay—five to five and a half months old

Heavy-breed pullet chicks should weigh about 10 oz at four weeks old, 18 oz at six weeks, 26–28 oz at eight weeks

Heavy-breed cockerels should attain an average weight of about 4 lb at 12 weeks, 5 5½ lb at 16 weeks (live weight), heavy-breed pullets 2½–3 lb and 3½–4 lb respectively

These may be taken as fair average figures, but there is a wide difference between individual strains and even batches of the same strain

Hatching Dates The table poultry producer buys chicks practically all the year round, except possibly for a short period in early summer

The egg producer rarely follows this practice, although some with large battery plants have consignments of chicks at monthly intervals throughout the year

TABLE 26

Food Consumption of Light Breed Pullets (Lippincott)

Week.	Food consumption, lb	Total food consumed, lb [1]
1	10	10
2	20	30
3	30	60
4	40	100
5	50	150
6	60	210
7	70	280
8	80	360
9	90	450
10	100	550
11	105	655
12	110	765
13	115	880
14	120	1,000
15	125	1,125
16	130	1,255
17	135	1,390
18	140	1,530
19	145	1,675
20	150	1,825
21	155	1,980
22	160	2,140
23	165	2,305
24	170	2,475

[1] This consumption may be expected when foods of first-class quality are fed

February to April inclusive is the most popular hatching season for the bulk of the pullet replacement stock, February- and March-hatched pullets being in keenest demand.

But an increasing number of producers purchase a proportion of their chicks in November and December; in fact, some have their largest intake at this time.

During recent years egg prices have favoured pre-Christmas hatching. Under intensive systems of housing November December-hatched pullets have been more profitable than spring-hatched birds.

Whether or not autumn-hatched pullets will continue to yield the greatest profit will depend on developments in the industry. Present trends indicate that with the swing to intensive methods egg prices will not show the wide seasonal differences of the past, although it is very improbable that uniformity will be obtained.

Autumn and winter egg prices are likely to remain higher than those of spring and summer

The prejudice against very early hatching i.e., during the closing months of the year, is due largely to the fact that these birds commence production comparatively early in life, they usually lay a larger percentage of small eggs than their sisters hatched in the spring, and they may moult in the autumn or early winter, when eggs are realizing their highest prices

Early-hatched pullets always mature at a rapid rate, and will often be in production a month or six weeks earlier than birds of the same strain hatched in the spring, but this rapid maturity is not necessarily associated with lack of body-size, provided the birds are well reared

Egg-size and body-size are inherited characters Waters (1937) found that although early-maturing birds laid smaller eggs at the start of laying than those maturing later, it does not follow that the latter's inherited egg size is greater than the former. At ten months of age, by which time both types will have attained final body-weight, the early-maturing birds will be laying eggs as large as the later starter Birds that lay at an early age grow very rapidly up to the date at which production commences, but their body-weight at ten months is approximately the same as those that mature later

All early-hatched pullets do not moult during the autumn or winter Individuals within a flock continue to lay, and it is possible by selection to build up a strain in which the incidence of winter moulting is low

Management, however, has considerable influence on the moult If the birds are liberally fed on a ration of high quality, and kept on an intensive system, artificial light being employed (starting for a short period early in August), moulting may be avoided or at least delayed Under favourable conditions, not more than about 10 per cent of early hatched pullets should moult, and those which do so usually moult very rapidly But out-of-season moulting will be extensive and prolonged if the birds are mismanaged Artificial lighting is essential to secure maximum returns from this class of stock

There is no doubt that as a general rule, late February to the end of the first week in April is the best time to hatch pullets

of the heavy breeds for maximum winter egg production and minimum risk of moulting in the autumn. But the more prolific strains mature rapidly, and there is in fact little difference in rate of maturity between them and the light breeds. Strain should therefore be studied.

Light breeds and crosses should be hatched from late March to the end of the first week in May.

However, it is rarely possible for the commercial man to have all his chicks at these times. When he cannot do so he should start earlier, rather than prolong the normal rearing season, because late chicks are not so satisfactory as those hatched early in the season. If, therefore, he must have some of his chicks early or late, he should choose the early chicks. Late-hatched chicks invariably mature slowly, and are far more susceptible to disease than their earlier-hatched sisters.

November–December-hatched pullets will start laying in April and May, and kept on an intensive system with artificial light employed from August onwards, it should be possible to keep the majority of them in lay until the spring or early summer of the following year, when they should be sold.

Many commercial producers with battery and deep-litter plants now adopt this plan.

Light and Growth. While artificial light is now widely employed in some degree for all classes of poultry, light does not, *per se*, promote growth, except in so far as it enables the birds to consume sufficient food to sustain maximum growth rate.

Thus for table-chicken production in intensive windowless houses artificial light is restricted in duration and intensity to amounts which promote rest and growth, discourage vices, but allow adequate feed intake.

Provided pullet chicks reared for laying have sufficient light hours per day in which to consume the amount of food necessary for normal growth – a minimum of eight hours – no useful purpose will be served by maintaining a longer day length.

Pullets reared under a constant short-day environment grow as rapidly and mature at the same age as pullets reared under a constant long-day environment.

Subject always to the minimum light hours being provided to ensure adequate food consumption, it is not the day length

that affects rate of maturity but the change in the light pattern

Thus, under natural lighting conditions early hatched pullets maturing as the day length is increasing start laying at an earlier age than pullets hatched in spring and summer, and are therefore maturing as the days are getting shorter

This is explained by the fact that while light does not promote growth, it stimulates the pituitary gland, which in turn stimulates the ovary, thus accelerating the onset of laying

The effect of artificial light on laying stock is discussed in Chapter Twelve

That it is the change of light pattern that affects age of sexual maturity has now been demonstrated at a number of centres

The influence of day length has been studied by Morris and Fox at Reading University

In one of the experiments carried out at this centre (1958) four groups each of 150 Rhode Island Red × Light Sussex pullets hatched December 4, 1957, were divided into two groups, one served as the control group and received natural daylight only, the other was given supplementary lighting to provide continuous illumination for the first week, thereafter the day length was reduced by 35 minutes each week to 14 hours 5 minutes at 17 weeks of age

Pullets in the control group began laying at 145 days old, those in the lighted group at 169 days old, a difference of 24 days in average age at first egg The control pullets were about 5 oz heavier than the lighted group at 20 weeks of age But the position was reversed by the time the latter came into lay, and they started at once to lay larger eggs

Light-restricted December-hatched pullets in fact laid early eggs of a size equal to that of April-hatched pullets of the same strain The net profit per bird was increased in this instance by 7*s* by restricted lighting

Morris and Fox (1958) reported that in a series of experiments begun in 1954 Rhode × Sussex pullets were hatched at weekly intervals from June 1954 to February 1956

Chicks of each hatch were reared in natural daylight to 16 weeks of age, when they were divided into two groups and housed in a battery house, where one group received daylight only, the other a 14-hour day from September to April The results again showed that rate of sexual maturity is increased

by increasing lengths of day and decreased by decreasing day lengths.

Thus it is not the length of day but the change in the length of day that affects the onset of laying.

In these experiments birds hatched in winter and reared under natural daylight conditions matured at 145 days, whereas those hatched at midsummer took 170–180—a difference of four or five weeks.

Colour of light is unimportant, provided it is of sufficient intensity for the chicks to feed well. But white light is the cheapest. Either tungsten or fluorescent lamps may be used.

For many years it was thought that green and blue light were less effective than red or white. Carson, Junnila and Bacon (1958, University of Connecticut) found no significant difference in various colour treatments. Their work did not confirm the assumption that certain colours were more effective than others.

All lighted pens in this experiment, which was carried out with September-hatched chicks, reached 50 per cent egg production at least three weeks earlier than the unlighted controls. The lighted pens had a 21-hour day from 15 weeks of age. All groups of chicks were reared under continuous lighting up to the 15th week.

There is no evidence that continuous lighting of chicks and growing stock, or indeed of layers, is harmful.

The matter of feeding hours for chicks was investigated at the Wye Experimental Station in 1915 and 1916. Feeding dry mash of normal composition three times daily for periods up to one hour for each meal proved unsatisfactory. It resulted in high mortality and poor growth. Feeding six times daily for periods of one hour for each meal resulted in mortality similar to that among chicks fed dry mash *ad lib.*, but the average weight of the former chicks at eight weeks old was about 17 oz., whereas that of the latter was about 25 oz.

"From these results it can be confidently stated that with dry mash feeding, it is sound practice to allow chicks free access to the mash." (Halnan, 1918.)

Experiments with wet-mash feeding showed that feeding chicks three times a day for sixty minutes at each meal was as

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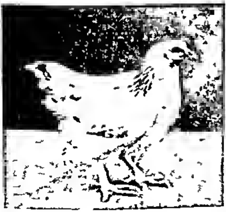
FIG. 122—SEXING LIGHT-BREED CHICKS

Light breed chicks are easily sexed when 3–4 weeks old The cockerels have bright red prominent combs and an aggressive appearance In the pullets the combs remain colourless and undeveloped until the birds are approaching maturity This is a White Leghorn cockerel (*left*) (*Right*) is seen a pullet of the same age.

effective as feeding six times for thirty minutes or six times for sixty minutes or even *ad lib.* feeding.

Separation of Sexes. Among light breeds the sexes should be separated as soon as they can be distinguished, because the males are very precocious and tend to worry the females.



Photos Modern Poultry Keeping

FIG 123—DISTINGUISHING THE SEXES OF HEAVY-BREED CHICKS

At about 8 weeks of age heavy-breed chicks can be sexed The pullets are well feathered, they have prominent tails, neater, more compact heads and bodies (*left*)—while the cockerels (*right*) are backward in feathering, show bareness on back and wingbows and their tails are undeveloped The birds are coarser in head and body points

Light breeds can be sexed at three to four weeks old, when the cockerels' combs are beginning to develop rapidly and become red in colour. The males are longer in leg and have more prominent tails than the pullets. They are also aggressive.

The pullets' combs remain undeveloped and yellowish in

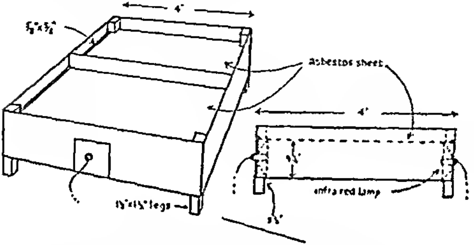


FIG. 123A.—A HOME-MADE INFRA-RED BROODER FOR 250 CHICKS.
The canopy should be covered with litter to conserve heat. Two 250 watt dull emitter heaters should be fitted as shown.

colour. They have shorter tails, the body is more compact and they have a shy disposition.

Heavy breeds can be sexed at about eight weeks, when cockerels will show coarser heads, bareness on back and wing-bows with pin feathers, and short, stubby tails. They have stouter and longer legs than pullets, deeper voices, and the body is coarser and more angular in appearance.

The pullets have smaller, more refined heads, the feathering is more forward and the tails are comparatively well developed. The legs are shorter and finer, and the body has a more symmetrical appearance compared with that of the cockerels.

Some breeders do not separate the sexes. They rear prospective stock cockerels with pullets. Certainly there can be no valid objection to this on the grounds that it is unnatural. The middle course is to separate the sexes, and when the cockerels are becoming sexually mature to run them with a flock of hens or laying pullets. This is preferable to con-

tinued isolation of mature males, which invariably leads to fighting and treading

If cockerels are reared together an adult cock should be kept with them from a relatively early age He will keep them in order

Photo Poultry Farmer and Packer

FIG 123B —INTENSIVE REARING UNITS

Three-tier rearing units in a controlled environment house Units have wire floors 8 ft × 3 ft per tier over 8 ft × 4 ft droppings trays Each tier houses 50 pullets from 4 weeks to 10–12 weeks old when they are moved from these units to battery cages

On this farm chicks reared in controlled environment houses have a constant 10-hour day from day old to 10–12 weeks of age when the day length is reduced progressively to 8 hours at 22 weeks of age Thereafter day length is increased 20 minutes each week up to 17 hours maximum

Chapter Eleven

Rearing Growing Pullets

When chicks are removed from the brooders it is customary to refer to them as "growers", the term implying young stock from six to eight weeks of age to about five months, when they should be placed in their permanent quarters.

The systems on which growing stock may be reared are numerous. The system adopted should be suitable for the farm, because it is essential to take into account the area and quality of the land available if the most effective use is to be made of the ground.

There is no greater mistake than to attempt free-range rearing where there is insufficient land for the purpose, because this results in over-stocking, the most prevalent cause of unsatisfactory growth and epidemic diseases that afflict young stock.

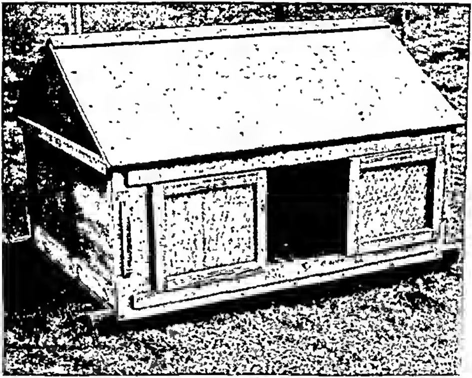
Given land of good quality it is wise to reckon that each growing pullet reared to maturity will require 10 sq. yd. of range, or, in round figures, about 400 pullets per acre. This is equivalent to 200 pullets per acre if half the ground is used in alternate years.

It is, of course, possible to stock the ground heavily for several months during the normal rearing season of spring and summer, provided all feathered stock are kept off the land during the winter months.

Limed periodically, judiciously grazed by sheep or cattle and used for approximately six months beginning in the spring, about 1,000 growing pullets could be reared per acre, year after year, on the same ground.

But continued success will depend on the quality of the turf and its management.

Free Range. The free-range system is ideal for the larger farms that are not unduly exposed, and, where conditions permit, this system should be carried out by all who are rearing



Photos: National Institute of Poultry Husbandry

FIG. 124.—STANDARD NIGHT ARK

Arks of this type are in use at the National Institute of Poultry Husbandry.
The ark has an overall measurement of 5 ft. × 3 ft. 6 in. and will house 60 chicks at six weeks old or 30 pullets to maturity.
The ark is built of 2-in. × 1-in. framing clad with exterior quality 6-mm. resin bonded plywood. It is mounted on 5-in. × 2-in. skids. There is a sliding door in the rear section of the roof. The slatted floor slides from the rear of the ark and rests on the skids. There is no droppings board. The run (10 × 5 × 2 ft.) is used for five days only after first transferring the chicks to the ark. Thereafter they have free range.

pullets, particularly birds that will eventually take their place in the breeding-pens.

If the benefits of free-range are to be secured, it is essential to have an abundance of ground that can be reserved exclusively for young stock. No adult birds should be kept on it at any time, while it is desirable to have alternate rearing ground available.

On general farms and the larger poultry farms pullets are frequently reared on temporary leys; thus the birds take their place in the farm's rotation.

It might be supposed that the above recommendations carry safety-first measures a little too far. It is true that on many successful farms range rearing is practised on comparatively small acres, that alternate ground is not available but there are many farms on which serious trouble has arisen because the same land has been used season after season. As a matter of prudence the poultry-man should have fresh ground available for his young stock.

The rearing-fields should be protected from the north and east winds. Land sloping gently to the south is ideal, particularly if it has a few trees or bushes to provide protection against the hot summer sun.

Orchards are excellent rearing-grounds, since they provide shelter for the birds, which consume large quantities of injurious insects. Heavy stocking should be avoided on account of the high nitrogen content of the manure.

If the fields are devoid of natural protection, then it is wise to erect galvanized-iron sheets, hurdles or other screens that will give shelter from the winter winds and summer sun. Straw bales are useful for this purpose.

The night ark, for so long pre-eminent among range housing for growing stock, is now challenged by the range shelter; indeed, the latter is widely employed on farms in all parts of the country.

The so-called Sussex ark is usually about 6 ft. × 3 ft., with slatted floor and full-span roof; the apex ark has, as its name implies, an apex roof rising from floor level.

Great care must be taken to avoid chilling when young birds are moved to arks early in the season.

Many suspend a hurricane lamp in each ark for about the

first week—depending, of course, on the age of the chicks and weather conditions. This not only takes the chill off the atmosphere, but also induces the birds to spread themselves over the floor instead of crowding in corners.

Also, in very cold weather the slatted floor should be covered with straw. The birds will gradually scratch this through the floor, but by that time it will have fulfilled its purpose—namely, to make the change from solid to slatted floor-housing less

Photo Modern Poul'ry Keeping

FIG. 125—A FLOCK OF GROWING PULLETS HOUSED IN SUSSEX NIGHT ARKS

The arks are well spaced and arranged in orderly fashion

drastic. Failing straw, the floor may be covered with sacks turned up in the corners of the ark to provide ventilation.

If it is desired to move chicks about four weeks old to arks, hay-box principles may be adopted. A hay canopy can be made by fixing hessian cloth (sacks) to hooks or framing a suitable height from the floor. The framing should be covered with hay, the slatted floor with hay or straw.

Much overcrowding occurs in night arks, either because the poultry-man fails to realize that healthy youngsters grow at a rapid rate, or because the arks are placed too close together, resulting in overcrowding in some arks while others contain only an odd bird or two.

The number of birds housed in an ark is a matter that must be left to the discretion of the rearer. He should consider the birds' development and the weather. As a guide, however, it may be stated that a 6-ft. × 3-ft. ark will accommodate up to seventy eight-weeks-old birds, fifty at three months old, thirty-five at four months and thirty from four months to maturity.

It is not suggested, of course, that each ark should have its full complement of chicks at eight weeks old, the number being reduced as they grow. Such practice would complicate man-

Photo: Modern Poultry Keeper

FIG. 126—UNGRADED STOCK

Unless growing stock on range are graded and kept in flocks of about the same age, they crowd together at feeding time and the younger chicks do not have their fair share of the food.

agement and add to its cost. Arks, and indeed all other types of growers' houses, should have the number of chicks they will comfortably accommodate up to the age it is proposed to transfer them to their permanent quarters or to sell the birds as growing stock.

Night arks should be spaced at least 10 yards apart in one or more files, facing the same direction. The farther they are placed apart the better, as far as the stock is concerned, since the greater the distance the smaller the risk of crowding, but of course it would not be economic to have them too widely scattered about the farm.

On some farms the arks or rearing-houses are placed in

groups or so-called compounds There is no valid objection to this method, provided the birds in each group are of the same age and the total head of stock in each group is no greater than the number the rearer can keep under proper observation The groups should, of course, be sufficiently far apart to prevent their getting mixed, except for occasional birds which seem to possess nomadic instincts

Arks should be arranged in orderly fashion with the object of reducing labour costs as much as possible consistent with good management They should not be placed indiscriminately about the field, some facing one way, others another. This would result in much unnecessary labour in routine management, and almost certainly in the course of the season the attendant would overlook one or more arks occasionally The birds may then be confined for the whole day, or, if the oversight occurred at night, they may be killed by foxes

When the arks are arranged in rows this is unlikely to happen, since before leaving the field a glance down each row will show whether or not each ark has received attention

In order to ensure uniform distribution of stock, food and water should be provided close to each ark This will encourage the birds to keep to their own units, instead of crowding into others, though in practice mixing of flocks to some extent is almost inevitable It will not, however, become serious if the above-mentioned precautions are taken

The Range Shelter. The range shelter is preferable to night arks *This consists of a series of perches under a low apex roof* The sides are covered with 1-in mesh wire netting, with a wire door in each end A wire floor is an advantage

Some shelters are without perches They are fitted with slatted or wire floors raised 6–9 in from the ground

Constructional details of two types of shelter are given in Chapter Nineteen

Shelters, however, differ widely in design and general construction Some consist of a shelter about 8 ft × 4 ft with wire-covered front and end sections, the back being boarded up or covered with a galvanized-iron sheet Five perches may be fitted about 1 ft 3 in from the ground on each side of a central door

Others provide much greater protection, three sides may be

boarded or fitted with removable panels, only the front of the shelter being covered with netting. Shelters of this type have all round ventilation under the wire or slatted floor. Some are fitted with droppings boards.

Clearly chicks can be moved at an earlier age to shelters which provide ample protection than to those of the open-sided type, but as a rule it is inadvisable to put chicks under seven or eight weeks old in them, especially those with open sides.

Range shelters ensure a fresh air life for the birds and prevent overcrowding. Being light in construction, they are easily moved, and provide perfect housing conditions for growing stock.

Before moving the chicks the sexes should be separated. *Cockerels intended for table should be set aside for fattening.* Their management is discussed in the chapter on table poultry.

Cockerels destined for the breeding pens should, like the pullets, be reared on free range wherever possible, and their management should be precisely the same as that of the pullets.

Chicks should be carefully selected when taken from the brooders. Only those of first class quality should be reared for laying. Chicks below standard, if considered of sufficiently good quality, should be fattened for table, but any birds obviously stunted in growth should be discarded. In some instances where individual chicks have every appearance of being healthy, but are a little backward, it may pay to put them with a rather younger batch, since their condition is probably due to nervousness. Placed with birds of equal development, they may make satisfactory progress, but they should be marked by leg ring or wing band to denote their age.

Culling and grading when moving chicks to their rearing quarters is important work, because it is essential to have uniform, well-developed batches of growing stock. The poultry man who understands his work will see that uniformity is maintained throughout the rearing period. He will keep the birds under close observation, and cull those that do not keep pace with their companions.

When growing stock are first placed in arks or other type of range rearing house, a temporary run of wire netting or hurdles should be erected to confine the birds to the vicinity of their roosting quarters for the first few days. In the course of two

three days they will be familiar with their surroundings and will go into the ark at night

Slats or a strip of wire should be nailed temporarily to the front legs of the ark to prevent the chicks getting underneath and so escaping from the run To give young chicks easy access to the ark, a run-up board, piece of turf or a brick should be used for a time Chicks are easily chilled early in the season if they huddle in the run, because they either cannot or will not jump up to the slatted floor

If the arks are placed 20–30 yd apart the use of temporary runs is unnecessary In that event the birds should be moved to the arks in the late afternoon and confined to them until the following morning, when a food and water trough should be placed outside each ark

As a further safeguard against crowding, some breeders place coloured birds in one row of arks, white birds in another If the arks are spaced well apart coloured and white birds rarely use the same ark

When housing in range shelters the birds should also be taken to them in the late afternoon, but they can be confined for the following day, provided food and water are available in the shelters

The tendency for birds in units sited rather closely together to crowd in one or more shelters is reduced when they are kept in them for the day after the birds are housed

Another very popular type of rearing house is the portable solid floor colony house with perches This may be of simple lean-to or full span design, with sliding or lifting shutters in front and a floor-light at the back

Many favour the colony house because, equipped with hover, it can be used for rearing from the day-old stage, and in due course the hover can be removed and the chicks run on until they are mature

Thus a change of housing at six or eight weeks of age is unnecessary, and since the house is small and readily portable, the chicks can be moved to fresh ground daily if desired Some colony houses are fitted with solid floors that can be replaced by slatted floors for the growing stage, and later on nest-boxes may be installed Thus some of the birds may spend their life in one house

Folding units are quite suitable for growing stock, and are in fact used on a number of farms. The advantages of the system are discussed in Chapter Three. These units, however, do not provide free range, and it must be remembered that where birds are closely confined there is a tendency for them to acquire bad habits. Moreover, the folding system entails much labour.

Photo: Poultry Farmer and Packer

FIG. 126A. UNIFORM GROUPS OF GROWING PULLETS HOUSED IN RANGE SHELTERS 10 FT. × 9 FT. × 6 FT. HIGH

Shelters have a galvanised iron roof. Floors are of 3-in. × 1-in. wire mesh 6 in. from the ground. Shelters have a pull-out food trough on each side.

Whatever type of house is used for range-rearing, it must be portable, and it should be moved to fresh ground at frequent intervals throughout the season. Leaving the house in the same position for long periods, possibly for the season, deprives the birds of the benefits of free range and creates the conditions that have been responsible for the failure, or more correctly the partial failure, of the orthodox semi-intensive system.

Birds do not wander far from their houses, with the result that if these are not moved the ground in the vicinity is over-stocked and almost devoid of grass, while further afield it is but little grazed and in summer-time the grass grows long and rank. Such conditions cannot be described as free range, yet they are commonly seen on poultry-farms as well as on mixed farms. They are thoroughly bad for the birds and the land.

The poultry-man who adopts free-range methods should

move the house frequently and keep the grass short. These are two of the many rules he must apply in the management of growing stock.

Short grass is a valuable asset on any farm. The poultryman should fully exploit it. The pity is that so many permit the rearing-ground to deteriorate into a series of over-stocked areas surrounded by long, prairie-like grass. It then becomes a menace to the health of the stock.

Rearing Pullets in Confinement. Broadly, it may be said that there are two methods of rearing growing stock: in total confinement and on free range.

Free range, or the folding system, is recommended where sufficient land of the right kind is available; but thousands of poultry-keepers are unable to give their birds free range, or even to approach it. They have not sufficient land for the purpose. That being so, they should not attempt to practise the methods employed on large farms. Should they do so, they will almost certainly create serious difficulties.

The man who is restricted to a few acres of ground should adopt fully intensive methods or rear the birds in straw, gravel or concrete yards.

Nothing can be gained, and much may be lost, by rearing in small runs that will sooner or later become foul. There is no insuperable difficulty in rearing in total confinement, no problem that cannot be solved by the application of commonsense methods.

But today intensive rearing is practised increasingly on farms irrespective of their acreage. It saves labour, losses from foxes and other depredators, avoids weather hazards and enables light patterns to be applied.

Any house designed to accommodate adult stock in total confinement is equally suitable for growers. Give the birds an abundance of room, fresh air, an adequate ration and sufficient light, natural or artificial, and success, in so far as it is dependent on environment, is assured.

Many failures have been due to overcrowding. From eight to twelve weeks of age floor-space equivalent to not less than 2 sq. ft. per bird should be provided; from twelve to sixteen weeks, 2½ sq. ft. should be regarded as the minimum; and thereafter 3 sq. ft. per bird will be required for flocks of from

fifty upwards. For smaller flocks allowances should be increased by approximately ½ sq. ft. per bird.

The above figures refer to flocks totally confined on a solid floor, but economy can be effected by the use of sun balconies, as already recommended for chicks. Sun balconies are an excellent investment. They are inexpensive and enable the number of birds kept in a house to be increased by approxi-

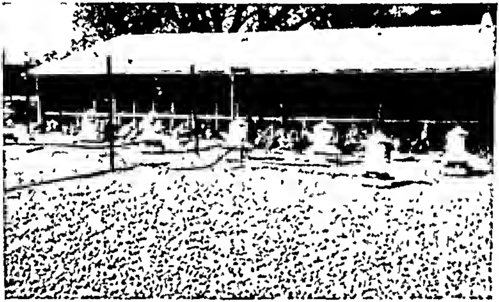


Photo: Poultry Farmer and Feeder

FIG. 126B OPEN-FRONTED HOUSES WITH LITTER YARDS, USED FOR REARING GROWING PULLETS

mately one-third. Food and water should be provided in the balconies as well as in the houses, and steps should be taken to give the birds protection from cold winds and the blazing heat of the sun

For growing stock sun balconies should be constructed on precisely the same principle as that recommended for chicks, except of course that they should provide more head room and the supporting timbers should be sufficiently strong to carry the greater weight

When growing chicks are moved to solid-floor houses they should not be permitted to sleep on the floor. Slatted frames are advised for the first few weeks, but the sooner the birds use the perches or slatted roosts in the normal position for adult birds the better

Litter management differs in no way from that advised for the deep litter system The litter must be crumbly—dry at all times, damp, caked areas, particularly liable to occur about the food and water troughs, must be avoided, if necessary by replacement of the litter at these points

During the summer months windows should be kept open day and night Wire doors should be used, since they will assist in keeping the houses cool

Ventilation must be abundant Lack of fresh air will quickly result in the birds becoming loose feathered, anæmic and debilitated It is the most prevalent cause of poor growth under intensive conditions

"Growers", in common with other classes of stock kept in total confinement, should have dry mash in preference to pellets, since the former provides more occupation

Among all birds closely confined there is a tendency towards feather plucking and cannibalism, due in the main to idleness Keeping them busy is the best precautionary measure, and dry mash will be of greater assistance in this respect than wet mash When the latter is fed, the birds quickly fill their crops and then spend much of their time standing about It is while they are idle that the trouble usually starts

For this reason an all pellet diet is not recommended although pellets may be given as a supplement The diet must, of course, be properly balanced for intensive rearing An abundance of feeding space is essential

Given a balanced diet, it is unnecessary to supply fresh green food Thousands of intensively housed pullets are reared without it, but there is no doubt that they relish it and it is of value in preventing vices

Cabbage, kale and other crops are excellent, they should be fed in racks In summer short, fresh lawn clippings may be given in troughs In the absence of fresh greenstuff in winter roots may be fed, although, with the exception of yellow carrots, they do not furnish pigment for colouring the yolk or pro vitamin A

While fresh green food is unnecessary if a supply is at hand moderate amounts can be usefully employed in rearing intensively housed pullets

Yard Systems Rearing growing pullets in straw, pebble

and concrete yards has been practised for many years on farms in all parts of the country.

These systems have long passed the experimental stage; no one need hesitate to adopt them, provided the yards are properly constructed and the stock is managed efficiently.

Yard area equivalent to 2½–3½ sq. ft. per bird is adequate for units of 250–300 birds, but conditions will be improved—and straw conserved—if a small part of the yard is covered. Covering may be effected by extending the roof of the house section for 2–3 ft.

House part should have an open front covered with wire netting. It should have a slatted or wire roost with a small littered section between roost and front of house. Total house area for growing pullets need not exceed ¾ sq. ft. per bird.

In normal circumstances about 1 ton straw will be required for a flock of 200 pullets, but more may be needed in a wet season.

Yards must be well drained. Main hazard in rearing in straw-yards arises from round-worm infestation. Some flocks are severely affected by these parasites, and although the birds can be treated, there is no practicable method of dealing quickly and effectively with contaminated yards.

In the event of an outbreak, yards should be cleaned, dressed with lime and left unoccupied for at least a year.

Rearing on Wire or Slatted Floors. Poultry-men working on fully intensive lines—as, for example, owners of laying-battery plants—may rear the growing stock on wire or slatted floors throughout.

This system is not one that appeals to the writer, but it may be adopted with success provided the birds are reared in small units and are not overcrowded.

Static rearing units are becoming increasingly popular, more particularly for the purpose of rearing pullets for commercial egg production. Many large battery plants have rearing sections equipped with units of this type.

The unit consists of a slatted-floor roosting section about 6 ft. × 4 ft., to which is attached a wire or slatted-floor covered run 12 ft. × 6 ft. or about 16 ft. × 6 ft. overall.

Roof may be of the full-span or lean-to type, the latter being most commonly adopted. Food troughs are fitted along both sides of the run, with a water trough at one end.

Roof is usually about 3 ft. 4 in from the floor at the front eaves, falling to about 2 ft 8 in at the rear eaves Floors are about 2 ft 6 in from the ground.

A unit of the above dimensions will rear sixty heavy breed or seventy light breed pullets to point of lay. If desired, nest boxes can then be fitted, when the same number of pullets can be run on for laying

As a precaution against cannibalism, growing stock should be de-beaked when transferred to these units

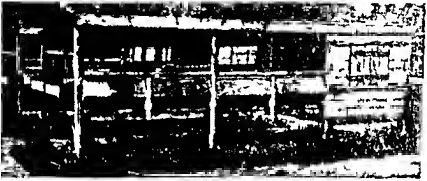


Photo Poultry Farmer and Packer

FIG 126C —REARING UNIT COMPRISING A SLATTED FLOOR ROOST SECTION 6 FT × 4 FT AND A WIRE-FLOOR RUN 11 FT × 6 FT

Each unit will house about 50 pullets from six weeks old to point of lay

Many use ordinary arks raised from the ground with wire-floor runs attached. The ark may have its normal complement of growers, that is to say about thirty birds to point of lay The run should provide about 1½ sq ft per bird, e g, a 6-ft × 3-ft. ark should have a 6-ft × 8-ft wire or slatted floor run

Some when rearing battery replacement pullets house up to forty pullets per ark with a 6-ft × 8-ft run, moving them into battery cages at four months old This area is adequate for birds up to this age

The cage or battery system of rearing growing pullets is practised on some battery plants

After the carry-on stage the pullets are moved to indoor wire-floor rearing units, usually built in three tiers similar to laying battery cages, in fact, some of the units are convertible into laying batteries by installing battery floors of conventional design.

Rearing units of this type differ in dimensions and constructional details, but they follow a common general plan.

Each compartment or cage may be 3 ft. × 2 ft. Built in three tiers, a block of cages 30 ft. long will accommodate some 450-500 pullets to point of lay, *i.e.*, 10-11 birds per cage. Actual capacity will depend on the type of pullet.

Some units are fitted with power-operated cleaning and hopper feeding. Daily routine tasks required in a house of about 2,000 pullets can then be completed in a few minutes.

It must be emphasized, however, that as in laying battery management, time must be allowed for observation of the stock, occasional handling of a random sample of the birds and for noting all those points on which their welfare depends.

Management of Growing Stock. There is no doubt that good range conditions are ideal for growing stock, but, whatever the system of rearing may be, every effort should be made to ensure that the birds make normal growth. Any check to their development, from whatever cause and however slight, must be regarded as serious, because they never fully recover in the sense that such birds do not do so well as those that have made steady progress throughout the rearing period.

Growing pullets should be handled periodically. This is essential in order that the rearer shall know their condition; he can then make the necessary alterations in feeding or management if he finds it unsatisfactory. He should not conclude that all is well merely because the birds have a healthy appearance and losses are negligible. They may be under-weight owing to under-feeding or other factors, but, whatever the cause, it must be found and removed.

In hot weather shade is essential. Long exposure to the sun is most injurious. The birds become very distressed, they lose their appetites, and consequently growth is retarded. If natural shade is not available, then it must be provided by other means.

Insect pests are especially apt to be troublesome in summertime, when they breed at a rapid rate. If they establish themselves they are soon present in large numbers, causing intense irritation, preventing the birds having proper rest, and if red mites are concerned, sucking their blood. Stock will not make satisfactory growth if tormented by external parasites.

At frequent intervals throughout the rearing season the birds should be examined for the presence of lice the perches, slats and cracks and crevices of the house for red mites These parasites are easily destroyed Blood sucking parasites are most injurious, and there can be no excuse for allowing them to play havoc with the health of the stock—as they will do unless the simple measures for their eradication are promptly applied

Lack of drinking water is another cause of retarded growth Birds require large quantities of water, particularly in hot weather and an abundant supply must be assured Drinking troughs should be sufficiently large or numerous to hold at least one day's supply, and they must be kept clean

Drinkers controlled by a ball tap connected to the main supply should be used wherever possible, even for range reared stock An automatic water supply is a great labour saver, and will raise the efficiency of the farm Capital so invested will show a substantial return

In hot weather the troughs should be placed in the shade Much nonsense has been written about the alleged injurious effects of sun warmed water It cannot be injurious unless contaminated with pathogenic organisms The object of keeping it in the shade in hot weather is not because warm water is injurious, but because cool water is more palatable and refreshing at such a time

For precisely the same reasons it is desirable to take the chill off the water in frosty weather In the winter months birds do not relish very cold water, they cannot drink it when frozen, and if its consumption is restricted they will lose condition to a greater or less extent

In the summer months close attention should be paid to the ventilation of the houses A house that will provide good con ditions for the stock in winter may fail in summer, unless the ventilation is made more abundant This commonly arises in the orthodox type of night ark During the late spring and summer only the wire door should be used, and if despite this the ark gets stuffy, more ridge ventilation should be provided or, failing this the roof door may be raised by placing a strip of wood under it

Arks are readily converted into shelters by making the boarded sides front and back as shutters and hinging them to

open outwards and upwards. They should be held up by stout hook-and-eye fasteners. When closed the shutters should fit well. They may be fastened with turn buttons.

Photo: Poultry Farmer and Packer

FIG. 127.—ARK CONVERSION

Arks may be converted into shelters by fitting hinged shutters along the back and front

Feeding the Growers. Change of diet should not coincide with change of quarters. Moving the birds to growers houses is a stress factor, and the effect should not be aggravated by superimposing the stress of replacing a chick with a growers' diet.

Chick diets should be fed for at least a fortnight after the birds are moved from the brooder house or carry-on units, as the case may be, that is to say until they are at least ten weeks and preferably twelve weeks old.

Many now adopt this policy, which is sound for two reasons. Not only is the double stress averted, but since a coccidiostat is commonly included in chick diets, the birds have the protection of the drug during the early post-brooder period while they are still susceptible to coccidiosis.

Some rearers when changing the diet at the 10–12-weeks-old stage introduce a layers' diet. They do not feed growers' diets, any "dilution" of layers' diets that may be necessary being effected by feeding grain. This procedure was adopted by the writer many years ago. Feeding and food storage are simplified.

The nutritive requirements of growing and laying stock do not differ widely enough to justify the use of specially compounded diets for growers.

For growing stock reared in total confinement dry mash feeding is advised, the mash being constantly available. Grain may be fed in addition provided the mash is suitable for feeding with it. Some give a light feed of grain in the morning and a heavier feed in the late afternoon, others may give a supplementary feed of pellets. Grain fed in the litter will help to keep the birds busy.

Completely balanced diets provide sufficient calcium, therefore no calcium grit is necessary. If the diet is likely to be deficient in calcium, oyster shell or limestone grit should be available. Insoluble grit (medium grade) should be supplied either *ad lib.* or if preferred at four-week intervals.

When the stock is reared on good-quality range there is a wide choice of feeding systems, all of which may be relied upon to give equally satisfactory results so far as the quality of the stock is concerned. The rearer should select the system which he considers most suitable for his purpose, and he should keep to it unless experience over a reasonable period indicates the need for modification.

On range, all-dry mash, wet mash or pellet feeding may be adopted, and foods in each of these forms may be given with grain. Experienced rearers have their favourite methods, and advance a variety of reasons for adopting them. Success depends on the man, not on the system.

If dry mash is preferred, the mash is usually fed *ad lib.*, with perhaps a light feed of grain in the morning and a full feed in the late afternoon. If wet mash is fed, it may be given in a crumbly condition as the first feed, with grain in the afternoon. Provided liberal helpings are given, two meals per day are sufficient at this stage.

Pellets may be fed *ad lib.*, with or without grain, or the young birds may be given a measured quantity of pellets daily, grain being given in addition.

Dry mash or pellets in conjunction with grain feeds are the two most popular methods of feeding growers on range, largely because they are labour-saving. All grain feeding is feasible during the spring and summer months provided the range is

adequate in quantity and quality, but cannot be generally advised unless conditions are exceptionally favourable.

On range it is naturally assumed that the birds will considerably supplement their ration, and therefore the question of feeding a ration complete in every respect does not assume so much importance as with birds reared in confinement.

During spring and summer on good-quality range there should be no deficiency of proteins, mineral matter or vitamins, because in normal circumstances sufficient will be furnished by grass, clover and insect life to compensate for any deficiency in the ration. In a hot, dry summer, however, when the grass gets burnt up and few worms and grubs can be found, there is some risk of the ration failing to supply all the requirements of the birds. In practice the greatest danger arises from lack of vitamin A. If therefore there is a shortage of grass, the ration should include 5 per cent of a good sample of dried grass or alfalfa meal.

The birds' appetites should be noted at all times. Should they tend to flag in hot weather, a slight alteration in the composition of the mash may be sufficient to restore them. If dry mash is fed, a small feed of wet mash at midday will be much relished, while the birds will often consume greedily grain that has been soaked in water for twenty-four hours. All these are matters for the consideration of the attendant. He must study the condition of his birds and the circumstances in which they are reared.

When wet mash is given as a supplementary feed to dry mash separate mixing is unnecessary. It will be sufficient to pour a little water over the dry mash in the troughs, enough to wet the surface layer.

During the later stages of rearing care must be taken to avoid under-feeding, which, strange as it may seem, occurs on a number of farms. As the birds approach maturity their appetites increase enormously, and these must be satisfied if the pullets are to be in good condition when moved to their permanent quarters. Many complaints of late maturity, poor and intermittent production are due to under-feeding in the late summer months.

The importance of keeping growing stock under observation cannot be over-emphasised. The attendant should watch the

birds closely at feeding times Any individual that fails to come to the food-trough should be handled, as should all birds showing symptoms of ill-health—namely, drooping wings, loose feathering, pale faces, diarrhoea and sluggish action They should be isolated immediately or killed Killing is usually the most profitable course, since it rarely pays to doctor individuals that become sick

But even when the birds appear to be in good condition, a representative number should be handled at intervals The flock may be under-weight, in which case the necessary alteration in feeding can be made before serious harm has been done

Growing stock must make steady progress, and be in prime condition at all times if they are to give the best returns in the laying-house

Retarding Egg Production The tendency for pullets to moult either partially or completely during the autumn or winter months is greater among birds commencing to lay before October than among those which begin laying later

Moreover, since early-hatched pullets normally mature at an earlier age than later-hatched stock, the former usually lay a greater number of small eggs

For these reasons attempts are often made to retard egg production by early-hatched or early maturing stock

Considerable skill is required in feeding to delay sexual maturity without harm Assuming that measures taken are successful, the commercial egg producer must study the economics of the procedure

The longer production is delayed, the more eggs must be laid subsequently to pay for the higher rearing costs Improvement in rate of laying following restricted feeding will not always balance the loss due to later maturity

For the egg producer " holding the birds back " is a doubtful proposition On the commercial farm it is wiser to feed normally and to regard the small first eggs of early layers as in the nature of a bonus

Breeders, however, are justified in delaying egg production in modern laying strains which mature at an exceptionally early age

Although results of experimental work are not entirely con

sistent, in the main they show that restricting food consumption during the growing period will delay sexual maturity for between two and three weeks without detriment to the stock, initial egg size is improved and there is usually lower laying-house mortality, particularly from prolapsus.

Restriction of food consumption equivalent to about 70 per cent of the total food the birds would consume if fed *ad lib.* is usually sufficient to achieve the purpose without harm. But restriction must be continued from 10–12 weeks of age until the birds are at point of lay or until production has reached the 5–10 per cent level.

Restriction to this extent is practicable for pullets on range with ample grass. For intensive rearing, feeding to about 80 per cent of full consumption is advised.

Quantitative restriction will depend on the quality of the diet. With diets of low calorific value and *pro rata* of protein, mineral and vitamin value there is a danger of imposing quantitative restriction on an existing qualitative restriction.

Restriction by limiting feeding time is usually of little value because the birds quickly learn to eat all they need in the time allotted to them, unless, of course, feeding time is severely curtailed.

Most rearers prefer to restrict consumption by diluting the diet with bulky material, such as oat feed, or, more usually, a high proportion of oats is fed in limited amounts.

An all-oat diet is only practicable when the birds are reared on range of good quality.

Most effective method of retarding the onset of laying is by control of lighting. The matter is discussed in Chapter Ten.

Control of the light pattern necessarily requires windowless houses and a completely reliable source of lighting. Power ventilation is also necessary.

Controlled lighting is not yet widely practised in pullet production, although it is being applied on an increasing scale, mainly by producers with large deep-litter units or battery plants.

Chapter Twelve

Management of Laying Stock

In order to secure a high rate of egg production it is essential that the birds be bred for the purpose, that they be well reared and well managed during their adult life

Perhaps the first two factors require rather greater emphasis than the last, because the effect of breeding and rearing is not uncommonly overlooked when egg production fails to attain the anticipated level

It is regrettable that inferior stock continues to sell readily, largely on account of its comparatively low initial cost If satisfactory returns are to be obtained from a flock, the birds must be well bred, and they cannot be bought at bargain prices Producers who do not breed their own replacements should buy their stock from a reputable breeder or hatchery and pay a fair price for it So called cheap stock is usually the most expensive in the long run

With regard to rearing, it should be realized that if the birds are to be in laying condition when placed in their permanent quarters they must make steady progress from the day-old stage Any factor that impedes their development will adversely affect their performance in the laying-house Frequently poor production is not due to mismanagement of the adult stock, but to one or more errors in management during the rearing period A bird that is not well reared cannot give full expression to her inherent ability as an egg producer

Houses should be thoroughly cleaned, disinfected and preferably re-littered before they are stocked with pullets It is advisable to leave the houses unoccupied for two or three weeks as a further precaution against the carry-over of infection from the previous flock

For floor litter, straw, wood shavings, and peat-moss are

most commonly used, whether or not the deep-litter system is practised. When the litter is to be replaced periodically during the season it is sufficient to cover the floor with peat moss to a depth of about 1 in., with straw or wood shavings to a depth of about 2 in.

Wheat and oat straw are superior to that of barley. The latter quickly breaks up, and the awns may cause injury to the bird's feet. Cavings are liable to blow about the house, they are not very absorbent, and after a time tend to form into lumps. They should be used with other litter such as peat moss or sawdust.

Choice of litter usually depends on what can be most readily and cheaply obtained locally. Hay should never be used on the floor, although it is suitable for nest-boxes.

Grading and Housing. All pullets should be placed in their permanent quarters three or four weeks before they are expected to start laying. This will give them time to settle down and become accustomed to the routine management of adult stock.

The birds should be carefully selected and graded as they are brought from the rearing-houses. Individuals that are obviously weaklings should be marketed as table birds as should those which are backward and clearly will be slow to mature.

The object of this work is, of course, to ensure uniform flocks—an important point in poultry management. It is impossible to secure maximum production from a flock containing birds that differ widely in their age and development. It is equally impossible efficiently to cull such flocks.

A week or ten days before moving the pullets they should be examined for lice and their quarters for red mites. Then, if necessary, treatment can be applied and the danger of introducing parasites with the stock averted.

Should there be evidence of worm infestation, the pullets should be given an appropriate vermifuge.

Large round worms (Ascaridia) are the most prevalent internal parasites, particularly where the birds are reared on straw yards.

Routine treatment with piperazine compounds prior to housing is practised on some farms.

Birds should be moved to range houses late in the day, and should be confined to them until the following morning, when the pop-hole should be opened, the birds being left to find their way out They should not be driven out

Always inspect the birds soon after dusk for the first few nights after moving them They may crowd on the floor or in nest-boxes It should be seen that they settle down comfortably

Birds should be moved to intensive houses in the morning or early afternoon to give them an opportunity of becoming familiar with their surroundings before nightfall Dusk inspection is essential, because they may not only crowd in corners but may also pile up, resulting in losses from suffocation or crushing Inspection should be carried out nightly until all the birds use the perches or slatted roosts

As a precaution against crowding, the corners of the house may be temporarily rounded off with wire netting

Egg Record Cards Egg record cards should be used for each house They should show the number of birds put in the house, the breed or cross, date of hatching and the name of the breeder Each card should bear the house number and should be ruled to show the daily production, with a column for the total for the month

There should be a wide margin for remarks in which notes should be clearly written Many poultry-men, in their haste to complete the daily round, make hurried notes that are illegible when reference is made to them some months later

The number of birds in the house should be known at all times so that a check can be kept on production

Cards should also provide for recording food consumption Many producers disregard the important factor of food conversion, they have no idea of the number of lb food required to produce a dozen eggs

Yet strains differ widely in this respect, moreover, if consumption appears to be abnormally high this may in fact be due to wastage Recording consumption may therefore lead to more efficient feeding

Keeping an account of food consumption is not an exacting task since it is necessary to record only consignments as they are taken into the house or stored in the appropriate bin in the granary as the case may be

At the end of the season the food conversion ratio is easily worked out in the meantime the poultryman will be able to make fairly accurate short period estimates

Some carry recording a stage further by marking on the cards the production point at which the flock becomes profitable they plot production and price of eggs against estimates of feeding and other costs

Routine Culling and Handling It by no means follows that even when the egg production from a given house is considered satisfactory every bird in the flock is pulling its weight If the best returns are to be obtained it is essential to keep the flock under close observation and to cull individuals showing those unmistakable signs of ill health and lack of vigour It is also necessary to cull those heavy coarse birds that convert food into fat instead of eggs and those occasional monstrosities the so-called cock hens

It should be remembered that at prev[illegible] price of proprietary feeding-stuff the cost of feeding [illegible] of production is in the region of 5*d* a week More[illegible] the market value of such birds is usually depreciating The sooner they are sold the better

Culling of this kind is a matter of routine It does not entail rounding up the flock to go through the birds individually, indeed, this practice would do far more harm than good, since it would make the birds nervous and have an adverse, if not disastrous, effect on egg production

As the poor or non-producers reveal themselves they should be caught by the leg with a catching hook, as should birds of doubtful quality required for handling

This work should be carried out with care, particularly when the birds are kept in confinement, for hurried or unusual movements by the attendant can easily throw the flock into a panic

During the first six months of the production year there should be few birds to be taken from the flock, thereafter the number should never exceed that which cannot be dealt with in the manner described in the course of a few minutes and with little disturbance

Should heavy culling be required in a well-reared, well-managed flock, a breeder of better quality stock should be found Today no one can afford to buy from a breeder whose stock demands constant culling

Advocates of handling laying stock have been much criticized in recent years In some quarters handling is regarded as serving no useful purpose, as more liable to decrease than increase average egg production But it has its part to play in management

Full-scale handling, as described later in this chapter, which involves taking every bird in hand to assess its condition is not justified, it is impracticable in large commercial flocks during the production year, but should always be carried out at the end of the season if some of the birds are retained for a second year for laying or for breeding purposes

Nevertheless, in the writer's opinion it is worth while adopting the practice of night culling by flashlamp This work is done most efficiently with an assistant to hold the lamp,

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which should direct a narrow beam of light through a ½-in aperture in a card placed behind the lamp glass Too wide an area of light will cause some of the birds to move away from the culler and even to leave the perches

The primary purpose of this night inspection is to ascertain the condition of the flock by feeling the abdomens of a random sample of the birds This can be done without lifting them off the perches, although a few may be *taken in hand if further* handling is considered necessary

The work even among large flocks can be completed in a few minutes If repeated at intervals of about one month the poultryman will know the condition of the flock and will be able to take the necessary remedial measures in good time should it not be satisfactory

Handling on the above lines will mean spending a little time among the birds at night, which in itself may be the means of detecting housing or other faults affecting the health of the stock

High egg production is not necessarily evidence that all is well with the flock The birds may be losing weight, and if they continue to do so a slump in production is inevitable, probably followed by widespread moulting

Feeding the Layers. *Experiments have proved conclusively* that each of the common systems of feeding is equally satisfactory Results depend not so much on the system—*e g*, on whether the mash is fed wet or dry—as on the application of the system and the *composition and palatability* of the *ration*

For intensively-kept stock the dry-mash system of feeding is recommended for the same reason that it is recommended for intensive chick rearing—namely, because it finds the birds more occupation than wet-mash or pellet feeding

Dry mash should be available at all times during the winter months Some make a practice of closing the hoppers for about two hours in the afternoon in summer, grain being given as the last feed of the day

In normal circumstances this procedure is not advised, because it adds to the labour cost, which is unlikely to be recovered in increased egg production or saving of mash

Under intensive conditions mash or pellets should be available to the birds at all times.

A full feed of grain should be given in troughs about one hour before dusk in winter-time and between 6 or 7 p m in summer, although on the larger farms it may be necessary to feed earlier on account of staff arrangements

During the short winter days, unless artificial lighting is employed, a small feed of the same mash should be given in a moist, crumbly condition at midday This ensures sufficient mash consumption Instead of mixing wet mash and feeding in a separate trough, many simply pour a little water or skimmed milk over the dry mash The amount of water or milk required must be left to the feeder's discretion It is necessary to moisten only the top of the mash

Alternatively, a booster feed of pellets may be given in lieu of supplementary wet mash, indeed, pellets are now commonly used for this purpose

Whether or not additional feeding on the above lines is necessary under a system of artificial lighting will depend on the condition of the birds and the level of egg production In most cases egg production is the accepted guide, a booster feed being given when yield shows a progressive decline over a short term

For laying flocks in deep-litter houses with artificial light the grain feed should be given in the litter This will provide interest for the birds, and their scratching will assist in keeping the litter in good condition

Grain should be fed in the late afternoon, usually at the rate of about 2 oz. per head, but this will depend on the composition of the mash or pellets Some compounds are intended to be fed with not more than 1 oz grain

Dry-mash feeding is also recommended where birds are on range, and especially where they are kept in fold units

For birds on range, however, it is essential to provide mash both in the runs and the houses to ensure adequate consumption Outdoor food troughs should be moved about the runs, not left in one position

As on the intensive system, dry mash should be fed *ad lib*, preferably with a grain feed in the late afternoon

Should wet mash be favoured, two full meals should be given per day If grain is available a full feed of mash should be given in the morning, with grain in the afternoon, or a light

feed of grain in the early morning, wet mash about 11 a.m., with grain before dusk.

Pellets. Pellets are composed of the same ingredients as the mash—they are, in fact, compressed mash cut in small pieces about the size of grain. They are fed in precisely the same way as dry mash—in hoppers from which the birds help themselves.

Trials have shown that pelleting improves the efficiency of the diet. The reason for this is not clear, but it is suggested that both the physical and non-physical change effected by pelleting are responsible.

During the pelleting process the foodstuffs are subjected to heat and pressure, which it is believed bring about a chemical change in composition.

In experiments at Reading University Black, Jennings and Morris (1957) found that birds in cages receiving a daily allowance of 3¼ oz. pellets per bird had significantly more eggs than similar *birds* fed the *same* quantity of the same *diet* in mash form.

At this and other centres the feeding of pellets, whether *ad lib.* or in restricted amounts, resulted in greater gain in body weight compared with mash-fed birds. The increase in weight is usually, but not invariably, associated with greater food consumption.

Improved efficiency in feed conversion is also secured by feeding table chicks on pellets or crumbs instead of mash.

Crumbs are prepared from pellets. As the name implies, crumbs are in granular form. They are used extensively in chick rearing, and some favour them for laying stock in batteries. Crumbs find more occupation for the birds than pellets and cause less contamination of the drinking water than mash.

Those who favour pellet feeding assert that birds prefer food in granular rather than meal form and that pellets are not so wasteful as mash. On range certainly there is less waste compared with dry mash feeding, because wind cannot blow pellets out of the hoppers, but there should be little if any waste due to this cause if the hoppers are properly designed and not over filled.

Some birds acquire the habit of picking some of the pellets

are fed *ad lib.*, consumption is usually high—at times exceeding 6 oz. per head per day—and in view of this, on some farms the amount is restricted to 5–5½ oz. per bird or about 2½ oz. when grain is fed. Great care should be exercised in this matter, for restricted feeding often results in under-feeding especially the high producers.

Birds fed pellets *ad lib.* usually give higher winter production and finish the season in better condition than those given a restricted diet, therefore the net return is greater.

On range of good quality, however, the consumption of pellets may be restricted during the spring and summer months. The birds can be limited to the above-mentioned amounts or, alternatively, the hoppers can be opened for two hours or so in the morning. Grain being given in the late afternoon.

This will save a little food and encourage the birds to make fuller use of the range.

In winter *ad lib.* feeding of pellets is advised, and at all times if this method of feeding is adopted for flocks kept under intensive conditions.

The Grain Ration. For practical purposes wheat, barley and yellow maize may be regarded as about equal in nutritional value, and therefore largely interchangeable in the poultry diet. The poultryman will be influenced in his choice of these grains by market quotations.

Oats contain considerably more fibre, and samples are far more variable in quality than those of other grains. At times there is difficulty in securing oats of prime quality.

Maize, however, provides more energy than other grains, and in the writer's experience it has no equal for laying stock.

In feeding trials higher egg production was obtained from birds fed yellow maize than from those given any other cereal. Mash of the same composition was fed to each group of pullets.

Arable farmers usually rely on home-grown cereals to provide the grain ration, and in many cases a substantial part of the meals in the mash.

When maize is obtainable at prices in line with those of other cereals, however, it should be fed liberally when the birds are laying rapidly, and especially if there is a tendency for them to lose weight.

If the mash is properly balanced for grain feeding, the grain ration may consist of one cereal only if desired, although a mixed diet is to be preferred.

It should be remembered that grain is composed largely of starch, therefore if the birds tend to be getting over-fat it should be fed rather sparingly.

As a general rule grain should be fed in troughs to pullets in lay, but for second-year birds, particularly while they are out of production, it is usually advisable to feed it in the litter or in the grass. This is, of course, a matter for the poultryman to decide. He must study the condition of his birds.

As already stated, under deep-litter conditions it is customary to feed grain in the litter.

Observation. Feeding time presents a favourable opportunity for observation. Feeding should never be hurried. The attendant should spend some time among the birds, keeping a sharp look out for individuals that do not come to the troughs and those birds that are clearly non-producers and/or show evidence of ill-health.

The competent poultryman will soon have a docile flock, and will be able to pick up individual birds without causing commotion. *He will exercise every care to keep them quiet.* He will give warning of his approach to the house by whistling or knocking on the door. *So far as possible, he will avoid* carrying into the house anything with which the birds are not familiar.

Grit. Laying-stock must be provided with an abundance of shell-forming material. Lack of it will not only result in thin-shelled and shell-less eggs, but will also cause loss of egg production. Birds will not lay at their maximum rate if they are deprived of the materials essential for the production of egg-shells.

Calcium in some form is essential. Oyster shell and [illegible]

stone grit are most commonly used for this purpose In districts where cockle-shell is obtainable at an economic price the poultry-man should make use of it

Limestone grit should have a calcium carbonate content of not less than 95 per cent—the best grades will contain 98 per cent or more It should be purchased with a guarantee of its composition, because some samples are comparatively deficient in calcium

Experiments have shown that although birds may be kept in health and production without flint or other insoluble grit, a small proportion of the latter results in more efficient utilization of the food In other words, it is an aid to digestion About 15 or 20 per cent of the grit mixture should consist of flint, care being taken to avoid the very coarse grades frequently offered by merchants

Fine or medium grades of both flint and oyster-shell and limestone grits are preferable

Grit should be supplied in small hoppers or troughs, a constant supply being available to the birds

In laying-batteries it is customary to scatter it over the mash or to include 5 per cent of limestone flour in lieu of limestone grit or oyster-shell

Drinking-water. The importance of drinking-water should be stressed, because nothing will cause a slump in egg production so quickly as lack of it

The amount consumed is very considerable As an approximate estimate, about 5 gallons per 100 birds will be required daily Actual consumption from the drinking-troughs will depend on the system of feeding and weather conditions Birds having dry mash will drink more than those having wet mash, they will drink more in hot weather than in cold

It should be ensured that a constant supply is available, steps being taken to prevent the water from freezing in cold weather and to keep it as cool as possible in hot weather The more water the birds can be induced to drink the better for them and for their owner's pocket

One 10-in -diameter drinking-trough with automatic supply is adequate for about 150 adult birds, one open trough 2 ft long (4 ft trough space) for about 100

During hot weather shade is as important for laying-stock as for growers. Birds on range must be given some protection from the blazing sun if they are to maintain condition, and therefore production. Early moulting and a rapid decline in egg production are frequently due to failure to attend to this elementary point in management.

The birds' appetites and the condition of the grass should be closely watched during the summer months.

The same general principles apply as in the management of young stock, already discussed. In hot weather a slight change in feeding will often restore failing appetites. Dry-mash-fed birds may respond to a supplementary feed of wet mash, while a feed of soaked grain may be relished when interest in the food-troughs begins to flag.

Should grass be in short supply as a result of a spell of dry weather, it should be made certain that the ration provides an abundance of vitamin A.

Great care should be taken to keep laying-stock free from external parasites. They can cause much harm. It is never wise to assume that they are not present. The poultry-man who knows his business will examine the birds for lice and the perches or slats for red mites at short intervals throughout the year. He will also take immediate steps to eradicate the pests should he find them.

Conditions in the houses, especially with regard to ventilation and the avoidance of overcrowding, are of cardinal importance.

Inefficient ventilation is frequently responsible for outbreaks of respiratory and other diseases, but it must not be assumed that ventilation is satisfactory if they do not occur. Many complaints of poor production arise from the birds becoming debilitated as a result of stuffiness in the houses.

While ventilation should be abundant, draughts must be avoided. Cold to a degree experienced in this country will not harm the birds. The body can adjust itself to a wide temperature differential, but it cannot adjust itself to warmth on one side and cold on the other. That is why draughts are so dangerous.

When weather conditions permit, the shutters and doors of houses should be open day and night. If the house is properly constructed there is no need to close it unless rain is driving

in or a strong wind is creating a through draught—the latter refers mainly to battery and other "double-fronted" houses

Artificial Lighting. The artificial lighting of laying-houses has been practised by commercial egg producers for a great many years

The object of lighting is to secure maximum production during the winter months Lighting has little effect on the total number of eggs laid throughout the year, but it improves production during the winter at the expense of spring and summer output

In certain circumstances, however, notably in the case of early hatched birds, artificial lighting may bring about a significant increase in total output during the production year because it will diminish the incidence of autumn and winter moulting and shorten the winter pause

The effect of artificial lighting on total production is most marked where the birds are kept for a comparatively short laying season of 9–10 months, birds moulting in the winter then have insufficient time in which to make good the loss of output

For many years it was thought that the effect of lighting was the result of extending the birds' working day, thereby enabling them to consume more food, and consequently to lay more eggs

The work of a number of investigators has shown that this explanation is not correct Artificial light does not increase egg production because the birds consume more food Light stimulates the pituitary gland (a small gland at the base of the brain). This gland secretes several hormones, among them being that which produces increased activity of the ovary

The pituitary substance is carried to the ovary by way of the blood

Light rays are absorbed through the eyes

Although light is responsible for increased egg production, increased food consumption is necessary to maintain it Artificial lighting must be supported by liberal feeding if the desired effect is to be secured

Experiments have also shown that only the visible light rays are effective for this purpose The ultra-violet rays, which play so important a part in the assimilation of the mineral

constituents of the food, do not bring about an improvement in egg production.

Bissonnette, to whose work with starlings Rowan referred in his paper read at the World's Poultry Congress, 1936, found that red light was more effective than white, and that, compared with the controls, green light was actually inhibitory.

Some American work has shown that all-night lighting with 15-watt red lamps is as effective as ordinary night lighting, *i.e.*, 4–6 hours with 40-watt lamps. So far as the writer is aware, there is no evidence that red light is more effective than white in stimulating egg production in poultry.

More recent experiments have shown that colour of light is unimportant. Reference to light colour will be found on p. 310.

The effect of light stimulation is so great that even poor layers can be induced to lay at a comparatively rapid rate for a time, but only for a time, as they will do in ordinary circumstances in the spring.

Artificial lighting is the most powerful of all so-called stimulants, and is far more effective than "forcing" the birds by increasing the percentage of animal protein in the mash. This latter is commonly referred to as "forcing", but in fact it has no effect whatever, provided, of course, that the ration normally fed already contains an adequate proportion.

The judicious use of artificial light will ensure maximum winter egg production, it will speed up the rate of maturity of late-hatched pullets, and reduce the time required for older birds to complete the moult. It may prevent early hatched pullets moulting in the winter (see p. 308).

Systems of Lighting. There are six systems of lighting: morning lights, evening lights, a combination of morning and evening lights, the evening lunch, all-night lighting and "flash" or "shock" lighting. The latter is effective, but so far it has not been applied on a wide scale commercially. It consists of exposing the birds to light of high intensity for very short periods. *Lamps of 1500 watts are employed*, the birds being given a twenty seconds exposure at about 4 a.m., and again at 5 a.m. Shorter exposures have been used, also more frequent exposures.

Fox and Morris (1958) point out that none of the experi-

ments at Reading University has shown flash lighting to be superior to the standard fourteen hour day Since the "flash" equipment is more expensive, the technique is not recommended in practice Fox and Morris state that the assumption that high intensity illumination is required is probably false In one of their flash lighting trials 300 watt lamps used for ten second flashes at intervals of twenty minutes commencing at 3 a m proved more effective than 1,500 watt lamps providing three twenty second flashes at fifteen minute intervals $1\frac{1}{4}$ hours before sunrise Ten flashes of twenty seconds duration at fifteen minute intervals with 500 watt lamps were the most effective

All systems of artificial lighting give better results in terms of income from eggs than groups having no artificial lighting but all night lighting is not recommended While evidence of harmful effect is lacking, it is necessarily more expensive than limited lighting moreover, the latter is more suitable for normal routine management

The "evening" lunch implies lighting the houses for one hour about 8 or 9 p m It is commonly adopted by the small poultry keeper The majority of poultry farmers usually prefer to light the houses from dusk or in the morning, giving the birds a fourteen hour day

Electric lighting is the most convenient When it is available arrangements can be made to switch on the lights at a given time by means of a time switch, they can also be switched off automatically Time switches some incorporating a dimming device, are now part of the standard equipment of the poultry farm

Poultry men who wish to economize can make an efficient time switch with an alarm clock the alarm winding key and the tumbler light switch should he connected with strong string As the key unwinds it will operate the switch The clock must be securely fixed close to the switch

Evening lights require the use of a dimmer switch because if the lights are suddenly turned off the birds will sleep on the floor

Light Intensity Light intensity is important It is usually expressed *in terms of ft /candles* Two *ft /candles* at the level of the bird s head is probably minimum under practical

conditions, but due to the accumulation of dust on the lamps 3½ ft./candles will provide a margin of safety.

Light intensity can be measured by a photographic light meter graduated in ft./candles. It should be measured at extreme points of the house farthest from the lamps.

For many years one 40-watt lamp per 200 sq. ft. floor area was regarded as adequate. Light of this intensity will stimulate egg production, but is not optimum. A lamp of at least 60 watts is needed, while one of 100 watts will be most effective under average farm conditions.

Increasing light intensity does not imply that hours of lighting can be reduced. It is necessary to follow the same lighting routine whether 60- or 100-watt lamps are used.

Morris (1959) presented the following table of suitable installations for obtaining reasonably uniform intensity of 3 lumens per sq. ft. at floor level.

TABLE 28

Light Intensity for Laying Stock (Morris, 1959)

Distance between lamps each way (ft.)	Correct mounting height (ft.)	Wattage of lamp required (with reflector).
9	6	60
10½	7	60
12	8	75
13½	9	100

Double-shift System. At the National Institute of Poultry Husbandry work has been undertaken on the two-shift system for laying stock. Two flocks are kept in the same house, one flock comprising the day shift, the other the night shift.

The change of shift is effected by driving the birds into a section of the house when the birds in the roosting room (a boarded-up part of the house usually fitted with a slatted roost) are let out into the unoccupied littered section. Then the birds going off duty are admitted to the sleeping quarters, and when confined to it birds of the new shift are given the run of the "day" part of the house.

Artificial light is provided in both the "day" and "night" section, so that a 14-hour day can be operated for both flocks.

Light Pattern. While a fourteen-hour day is usually employed for laying stock, since any decline in day length tends

to cause a fall in egg production Morris (1959) suggested that birds laying at mid summer should have a seventeen-hour day thereafter

Thus pullets hatched from July to January inclusive should have no artificial light until mid summer, then a seventeen-hour day, pullets hatched from February to June should have no artificial light until egg production reaches 50 per cent and again a seventeen-hour day after mid-summer.

King, 1958, created a sensation by disclosing results obtained by progressively increasing hours of lighting laying stock in experiments at the Alabama Polytechnic Institute

King adopted a system which has become known as " Stimulighting "

He reared a group of pullets in a blacked-out house in which they had a six-hour day from day to five months old

At this age light was increased by 18 minutes daily per week for the twelve months production period, *i e*, they had 18 minutes longer day each week than they had the week before

A control group of pullets was given a twelve-hour day until five months old, then a fourteen-hour day during the laying year

Both groups came into production at about the same time, but the experimental group produced over four dozen more eggs per bird than the control group, which averaged 215 eggs per bird

The high production of the experimental group compared with the controls after the first three months of lay was a notable feature of this experiment

King subsequently stated that the good result achieved from " stimulighting " was in fact related as much to reduced mortality as to light stimulation

Comparable results have not been secured in other experiments Evidence that increasing the light pattern over 17 hours will increase egg production significantly is not conclusive

The effect of light on the onset of sexual maturity has resulted in some egg producers using windowless houses By so doing they can control within narrow limits the rate of maturity, they can apply " stimulighting " to pullets should they desire to do so

Lamps should be fitted with reflectors, and arranged to

ensure uniform distribution of light. They should light the perches and drinking-vessels as well as the food troughs.

Lamps and reflectors must be kept clean.

If fluorescent lighting is favoured it should be borne in mind that these units provide about 2½ times more light than tungsten lamps of corresponding wattage. The life of fluorescent tubes is usually estimated at about 5,000 hours, whereas that of tungsten lamps is about 1,000 hours.

Fluorescent lamps cost more to install, but are far cheaper to run than tungsten lamps.

Failing electricity, gas or paraffin-vapour lamps (mantle type) are recommended.

A 300-candle-power paraffin vapour lamp will be sufficient for 400 sq. ft. floor area. This is a liberal allowance, but lamps should not be placed more than 20 ft. apart.

Houses in which artificial light is employed should have white or light-coloured interior walls to reflect the light.

For spring-hatched pullets artificial lighting should begin during September or the first week of October. For autumn hatched pullets lighting should begin early in August. A start should be made by lighting for about ½ hour, gradually increasing the hours of lighting as the days get shorter to give a sixteen-hour day in winter.

Early hatched pullets will have been in lay for some time prior to August. Lighting from this month as advised will help to keep them in production and avert autumn moulting. It is particularly valuable in hot weather when appetites tend to flag.

Late-hatched pullets coming into production during the short winter days should not be given a fourteen-hour day *immediately they are housed. Sudden introduction of a* fourteen-hour day at this season is liable to prove too stimulating. Losses from prolapsus may be numerous.

In these circumstances it is advisable to start with an eight-hour day increasing 1–2 hours weekly up to fourteen hours.

This suggestion is made on the assumption that pullets have not had artificial light during the growing stage.

In every case lighting should be continued until early in April. If discontinued too early, the flock will probably moult.

Whatever system of lighting is adopted it must be continued throughout the winter, and the same routine must be followed Success will not be achieved if the houses are lighted at irregular hours or if lighting is temporarily discontinued

The birds must be well graded and well fed It is of primary importance that body-weight be maintained If the birds are not liberally fed with a properly balanced ration they will not maintain condition or egg production, the result will then be worse than if no lights are used

Artificial light is employed successfully for breeding stock Although some are opposed to it, an increasing number of breeders are making use of artificial light, particularly for hens It hastens a return to production following the moult

Management of Breeding-stock. There is no essential difference between the general management of breeding and laying-stock

Assuming that second-year and older birds are bred from, putting them on the stubbles for two or three months has much to recommend it For a time little if any hand feeding will be necessary, and ranging far and wide in search of food will be of considerable assistance in promoting that lean, hard condition so desirable in breeding-stock

If this course cannot be followed, free range, or at least grass runs, should be provided, and a comparatively bulky ration fed for a time Moulting should be encouraged towards the end of August or early in September

Second-year birds, particularly the heavy breeds, tend to become over-fat following the moult unless care is exercised with their feeding and management

There is no cause for anxiety with regard to individuals that moult rapidly and return to production without undue delay, but when the interval between the completion of the moult and laying is prolonged the risk of the stock becoming over-fat is considerable Any tendency in this direction may be countered by the use of bulky rations, maize being fed sparingly in the grain feed, as it is very rich in starch Plump white oats and wheat are preferable to maize for over fat stock

As the moult is approaching completion, however, artificial lighting should be introduced It is the best means of prevent-

ing the birds taking a protracted rest, with the consequent loss of breeding condition.

It is essential that breeding-stock should have an adequate diet; adequate, that is to say, for the purpose of reproduction. Many complaints of low hatchability are attributable to feeding diets that are deficient in riboflavin, animal protein complex and other essential factors, or to using properly compounded mashes intended for all-mash feeding with a grain feed, which of course has the effect of reducing mash consumption, and so causing a deficiency. If grain is fed, the mash diet should be compounded to provide for it.

Flock Condition. When handling birds, condition should be judged by that of the flock as a whole. Individuals should be ignored, for it is obviously impracticable to remove them for special feeding. Even if this were successful it is probable that they would revert to their former condition when returned to the flock. Individuals found to be over-fat are the poor producers, while those in poor condition either lack stamina or are suffering from disease. In any event, they should be culled.

Only when the average condition of the flock is unsatisfactory should steps be taken to put matters right.

The male birds must be kept under observation and handled periodically. Serious losses will occur should they lose condition and they are more apt to do so than is commonly supposed.

Some birds are so concerned for the welfare of their mates that they neglect themselves. This gallantry may be commendable, but its effects on the rearing season may be most serious. When birds of this self-sacrificing nature are found in the breeding-pens it is often suggested that they should be given an extra feed by themselves.

The wisdom of this advice is open to question. The wiser course would be to cull any bird failing to keep in good condition, unless the reason for the failure were an exceptionally good one.

Forcing the Moult. Birds normally begin to moult in August and September and are out of production for about eight to ten weeks. At this time eggs are fetching their highest prices.

It is obvious, therefore, that if they can be induced to moult in July or early in August, and can be brought back into pro-

duction in October, they will be more profitable. Hence the practice known as "forced moulting".

Unfortunately the birds cannot be relied upon to perform in the desired manner. The consequences of forcing the moult are extremely variable; the financial outcome highly speculative.

As a general rule, force-moulting flocks kept for table-egg production is not recommended. It is more profitable to take all practical steps to keep the birds in lay as long as possible and to market them when there is evidence that moulting will soon be widespread.

Few keep birds for a second year for egg production, but even if selected individuals are retained force moulting is a doubtful proposition.

Early hatched pullets should not be force-moulted merely because some drop their feathers in late summer or autumn. Every endeavour should be made to prevent moulting by liberal feeding, artificial lighting and sound general management.

In the case of breeding stock, however, the advantage of forcing the moult in the autumn is widely recognized. Unless this is done many of the most prolific producers will continue to lay well into October, some into November. They will not be in lay sufficiently early in the season to fulfil the requirements of modern practice.

For this class of stock, that is to say yearling and older birds, there is a good case for forcing the moult in late August or September. At this season the very drastic measures sometimes advocated to induce moulting are usually unnecessary.

Some breeders force-moult early hatched pullets in the autumn, mating the birds when they are approximately twelve months old. They are then fully mature and will have had a rest following the pullet flush of eggs.

Forcing the moult is far more difficult than it appears, and it is even more difficult to induce the birds to start laying when eggs are most needed.

Those who create the impression that the process is a simple one cannot be speaking from experience. Admittedly it is an easy matter to cause the majority of the birds in a flock to start moulting in late July or early August, but even at this time

the most prolific producers will continue to lay long after the others begin to drop their feathers, although their eggs will be smaller and will be produced at a slower rate. Even if forced moulting is entirely successful, getting the birds into production again presents considerable difficulty.

The earlier in the season forced moulting is attempted the more difficult the task. The third week of July is quite early enough, and better results will be obtained if it is delayed until the end of the first week in August.

Before attempting to force the moult, the flock should be well culled. It is useless to force-moult birds that will not be retained for a second season.

Having selected the birds, moulting is induced by a drastic reduction in the ration. Treatment must be comparatively severe if it is to be effective. If possible, the birds should be confined to their houses or moved to strange quarters. Free range is not desirable, particularly in a wet season, because a considerable amount of natural food would be available.

No mash or grain should be fed, but the birds should have access to a limited supply of bran, a little being given in the morning and again in the late afternoon. If bran is not available, give grain, preferably oats, very sparingly. Fresh green food should be given. Some advise withholding the drinking-water for one day, and then removing it every afternoon, but the writer does not recommend this course.

This drastic treatment will check production, and in due course the birds will begin to drop their feathers. How long the treatment should be continued will depend on circumstances. The earlier in the season the procedure is adopted, the better the condition of the stock, and the better the layers, the longer will be the time required. A week or ten days may be sufficient, but this is essentially a matter that must be left to the discretion of the poultry-man.

A point of importance, however, is that the birds must be well in the moult before more liberal rations are introduced. If they are at once given full rations as soon as a few feathers are dropped it is probable that many will return to production, the short rations having resulted in a partial moult only.

The extent of moulting should be measured by the dropping

of the primary (flight) feathers, of which there are ten The majority of the birds should have dropped five of these feathers before the layer's mash is reintroduced Then it should be given mixed in gradually increasing proportions with the bran Grain should also be fed more liberally In the course of about four or five weeks from the time the first steps were taken to force the moult, full rations should be fed

Artificial light is of considerable value in bringing the birds back into production and ensuring a satisfactory level of production throughout the winter

For birds that are to be used for breeding purposes the moult should be regarded as a period for rest and recuperation, for building up reserves They should have a balanced breeder's diet with grain, preferably plump white oats, unless the condition of the stock shows that grain of lower fibre content should be fed

Force-moulting by Drugs Robblee and Clandinin (1955) found that the addition of 0 1 per cent 2-amino-5-nitrothiazole to the diet of hens was effective in inducing the moult The drug was fed for a period of twenty-six days

The average time required for the birds to resume production after the use of the drug was discontinued was about twenty-four days

Production on a hen-housed basis was higher in hens which had been force-moulted by the addition of the drug to the ration than in hens force-moulted by restricting the feed intake.

The drug is available in this country It is sold under the trade name of "Entramin" and is used for the treatment of blackhead in turkeys

This drug must not be confused with the newer drug "Entramin A" (acinitrazole), now in common use for the control of blackhead, and which is superior for this purpose to 2-amino-5-nitrothiazole

Gabuten and Shaffner (1954) and others have demonstrated that moulting was induced by treatment with the hormone progesterone.

Shaffner (1955) reported that injection of the drug in 20-mg. and 40-mg doses caused birds to cease laying and moult within ten days to two weeks Eight weeks after treatment most of the birds had resumed production

Forcing the moult by treatment with progesterone is of greater scientific than practical interest at present.

Good results have been reported following the inclusion of 5 per cent magnesite (magnesium oxide) in the mash for 10–14 days.

This whitish grey powder makes the food unpalatable, and consequently reduces consumption. It will induce moulting without taking other steps to restrict food intake.

Trap-nesting Commercial Layers. This practice is not an economic proposition. The work is very exacting, and the poultry-man concerned only with table-egg production is not justified in undertaking it.

Handling and observation will show which birds are laying and which are not, and if the system of ringing already described is employed, the poor producers can be removed from the flock. If the birds are well graded and of the same or approximately the same age, it is possible to maintain a uniform flock throughout the year. This in itself is of the greatest assistance in securing a high level of production, because the poor layers become so conspicuous that no observant attendant could fail to notice them.

The trap-nests should be used only for breeding-stock and prospective breeding-stock.

Broody Hens. Broody hens, unless required for sitting purposes, should be removed from the nest immediately and placed in a slatted-floor broody-coop in good light and where air can circulate freely; or they may be put in a house without nests and kept in a small run during the day.

Broody-coops are most commonly used. The slats should be about 2 inches apart. Food- and water-troughs should be fitted to the front of the coop. Each coop should provide room for three to six birds. It should be placed in the house or near to it, to save time in dealing with the birds.

While in the coop broodies should be given layers' or breeders' mash, as the case may be, and an abundance of drinking-water.

Liberal feeding is essential, the object being to bring the birds back into production as quickly as possible. Short rations or grain-feeding only will have the opposite effect. If prompt action is taken, two or three days in the coop will usually be [illegible], and if the birds are then returned to the flock they

should be laying again in the course of ten to fourteen days after their removal

According to Godfrey and Jaap (1950) the administration of 15 mg of diethylstilboestrol appeared to be as effective in the treatment of broodiness as the coop method

The number of days elapsing between the onset of broodiness and the commencement of laying as well as the rate of lay, appeared to be about the same for both methods In fact, treatment with this drug is now common On many farms it has replaced the broody coop

(See Chemical Caponising, p 485)

Culling the Flock Culling refers to the removal of the poor- and non producers from the flock Its importance cannot be over emphasized, because on the efficiency with which the work is carried out depends the success of the farm It is not the outstanding producers that determine profits but the average production from the flock and the more effective the culling the higher will be the average output per bird

On well managed farms culling is continuous, because the competent poultry man will remove diseased birds and those not laying well as soon as they are detected This is done in the ordinary course of routine management Nevertheless, on most farms the bulk of the culling is carried out in the late summer, when the birds considered to be of sufficiently good quality to justify their retention for a second year, and birds intended for the breeding pens, are selected, all others being marketed

Catching the Birds Birds should be caught with as little disturbance as possible This can be done with a catching crate, which should be regarded as an essential part of the equipment of the farm (See p 360, 631)

A crate should hold twenty to thirty birds If placed against the door or pop hole, the birds can be gently driven into it With a number of crates placed end to end it is possible to have a flock of 100 birds under complete control in the course of a few minutes

If a crate is not available, a length of wire netting should be attached to the side of the house about 5 ft from the corner into which the birds can be driven and the wire drawn around them

An attendant should then enter the enclosure and hand the birds to the culler. Only a small group of birds should be driven into the netting at one time, or they will crowd into the corner when being caught and some of them may be smothered.

For catching individual birds the catching hook is recommended. This is designed on the same principle as the shepherd's crook, and is used in the same way, the birds being caught by the leg.

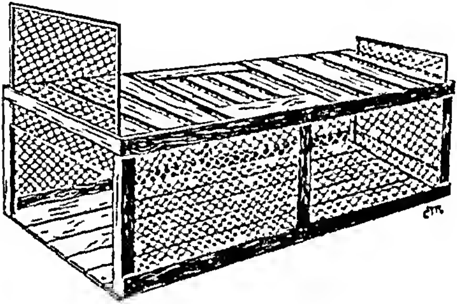


FIG. 128.—A CATCHING CRATE

A catching net, similar to the fisherman's landing net, is useful for catching individual birds in the run, although it causes rather more disturbance among the flock than most poultry-men consider desirable. This is especially so when used in a flock of light breeds. A catching net should not be used inside the house, for not only does it frighten the birds but it becomes caught on projecting nails and equipment generally.

Handling the Birds. When removing the birds from the crate slip the hand under the wing, palm towards the body, and the thumb over the wing close to the body. The bird can then be lifted out of the crate with the minimum of fluttering. A bird should not be grasped by the leg because she then

spreads her wings and may struggle violently. A bird is under better control when held by the wing in the manner described than by the legs, and there is no risk of causing injury.

When holding a bird for examination, the breast should rest on the palm of the hand with the head towards the handler. The legs should be held at the hocks between fingers and thumb and with one or two fingers between them. This leaves one hand completely free for examination.

The culler should handle every bird. He should first note

FIG. 129.—DURING THE EXAMINATION FLIGHTY BIRDS CAN BE CONTROLLED BY SHIFTING THE THUMB SO THAT IT GRIPS THE LARGE BONE IN THE WING NEXT TO THE BODY.

Photos Modern Poultry Keeping

AS THE ASSISTANT PASSES THE BIRD STERN FIRST, THE RIGHT HAND SLIPS UNDER THE RIGHT WING

Illustration shows how fingers clasp the breast Balance and distance between back and breast are automatically registered

general condition and whether or not a bird is in production. Some birds will be over-fat and handle like lead, others may be seriously under-weight with the breast-bones like knife-edges. Both these types should be marketed, for the simple reason that it will not be profitable to retain them.

With a well-managed flock, however, the great majority of the birds require closer examination before a decision should be made, because individuals that are obviously poor producers, weak or unhealthy will have been culled in the ordinary course of management.

No system of culling is infallible, and there is no poultry-

man whose judgment at times does not result in culling birds that should not be culled, but it is far wiser to cull rigorously, even if it means getting rid of a few potentially profitable layers, than not to cull at all

In order to cull as effectively as possible, it is essential to consider the management of the flock, and of course the time of the year. Unless these factors are taken into account, serious errors will be made. The birds may be in poor condition because of mismanagement, and if that is so the culler should then decide which birds are likely to respond when

Photo: Modern Poultry Keeper

FIG. 130.—HANDLING THE ABDOMEN

The feel of the gizzard is chiefly registered by the thumb from the left side and, if necessary, the first two fingers from the right side

INSPECTION OF HEAD AND EYE

After turning the head into position and feeling its reaction, the hand is then transferred to a position which is comfortable for bird and operator

the error in management has been corrected and which are not

Similarly, the season must be considered, because, other factors being equal, a flock handled in July will contain a greater proportion of birds in lay than if it is handled in September, when many of the birds will be moulting

After noting general condition the next step must be to find out whether or not a bird is laying. This is done by noting the condition of comb, wattles and face, the vent and pubic bones, as described in Chapter Six

As a rule, birds that are not laying during the late summer months are not worth keeping for a second season. It is true

that they may come into production in the autumn, but they rarely lay well enough for a sufficiently long period to warrant their retention. Usually after an early moult they lay for perhaps two months and then take a long rest, extending possibly until the spring. The bird that ceases to lay early in the season is almost invariably a poor producer.

In yellow-skinned breeds pigmentation is of some value in culling. Where a normal ration is being fed, and particularly

Photos: Modern Poultry Keeping

FIG. 131.—WORN PLUMAGE OF GOOD LAYERS

As the season advances good layers can be identified by the worn condition of the plumage. Frequent visits to the nests cause broken and worn tail feathers.

HEAD OF A PROLIFIC LAYER

The loss of the head feathers is a characteristic feature of many high producers.

where the birds have grass range, all individuals having deeply coloured shanks and beaks, with yellow in the vent, in the summer months should be culled, even though they are in good physical condition and have well-developed head-points. These birds are not in lay, and have not been in lay for a considerable time. With such birds prominent combs and wattles may indicate an abnormal condition of the reproductive organs.

The Moult. Of all factors used in culling, the time and duration of the moult are of the greatest significance. The matter has been discussed in Chapter Six.

Although moulting is a most valuable guide when culling, it is unfortunately true that many poultry-men fail to make the fullest use of it. On numerous farms early moulters are frequently overlooked; in some cases they complete the moult and come into production before autumn culling is undertaken. Then the culler is misled; he may even regard the bird as an exceptionally good layer and retain her a second year, possibly for breeding purposes.

The early moulter may be detected by her clean, bright plumage, and her dull, shrivelled head-points while she is out of production. If handled, pin-feathers will be seen. The plumage of a bird that has not moulted shows signs of wear and tear during the summer months, and the feathers are somewhat ragged or broken, especially those of the tail. White birds begin to look rather dirty compared with the snow-white plumage of their early moulting sisters.

Loss of Head Feathers. Many of the best layers tend to lose the head-feathers at the base of and immediately behind the comb. The reason for this is not understood. Nevertheless, the phenomenon is quite a common one to which considerable significance is attached when culling the flock. Care must be taken to distinguish between baldness due to laying and that which arises from the depluming mite and from over-mating. Some prolific layers also show bareness of the abdomen as the season advances.

When culling, too much attention should not be paid to any one character, unless of course it is a sufficiently serious defect to warrant immediate culling. In most instances a decision must be made, not with exceptionally poor or outstandingly good birds, but with those falling between the two extremes. It is therefore essential that all characters shall be duly considered, all evidence for and against a bird's retention carefully assessed before the final verdict is given.

For the experienced poultry-man culling individual birds is not a long process. Handling and observation are accomplished very rapidly.

First- and Second-year Production. As a rule first-year production is higher than that of the second and subsequent years. There is considerable difference between individuals in this respect, but a review of reports from a number

of centres shows that second-year production is about 80 per cent of the first This means that a bird laying 200 eggs in her first season may be expected to produce about 160 in her second season This applies to flocks showing comparatively good first-year records Birds with very high records usually show a greater decline in the second year On the contrary, with low-record birds the reduction in production is usually less marked It is by no means uncommon for very low first-year-record birds to give greater production in their second season

As an approximate estimate, however, it may be assumed that with flocks of good quality 75 to 80 per cent of the first-year production may be expected in the second year. A similar fall in production should be anticipated if the birds are kept for a third season

In estimating financial returns from second-year birds, the seasonal level of egg production must be considered In normal circumstances these birds are not laying, or are laying slowly during the period of higher winter egg prices This means that although they may lay 75 per cent of their first year's production, the cash return is considerably below this percentage

It is for this reason that most commercial egg-producers keep all-pullet flocks—that is to say, the whole of the laying stock is replaced annually

Management of Layers in Batteries. The management of birds in laying-battery cages, while similar to that of other systems of poultry-keeping in its general principles, presents problems peculiar to this modern method of egg production For example, it would be incorrect to refer to "the flock", at least in the generally accepted sense of the term, and hence the importance of uniformity of age and development of the birds does not apply to this system On the contrary, the fact that birds that die or fail to give satisfactory egg production can be replaced at once is one of the advantages of the system

It must not, however, be assumed that the battery is a fool-proof system Observation, stock sense and, it should be added, common sense are necessary for the successful operation of the battery plant

When the birds are brought into the battery house their

condition should be noted. They should be well grown and plump, but there is no need to reject birds that are somewhat backward and under weight. Their condition may be due to nervousness or possibly intestinal parasites. Should this be so they will probably respond to the environment of the battery, where they are not bullied by other birds and where in time internal parasites will be got rid of because re-infestation is prevented.[1]

Birds of this type should be given an opportunity of proving their worth under battery conditions, but the cages in which they are placed should be marked to call the attendant's attention to them. The progress of these birds should be noted. If in the course of, say, two or three weeks' time their condition has not improved, then they must be reconsidered.

Birds markedly under size and obviously weaklings should not be placed in cages.

Pullets should be placed in the cages when four and a half to five months old. They should not be moved after they have started laying, because this would check production, and if they were moved in the autumn or winter months it is probable that moulting would result.

On commercial plants it is an advantage to have each batch of birds in the same block or blocks of cages. This will be of considerable help in routine work, and will give a more complete picture of the performance of each lot than is possible if the birds are placed here and there about the battery.

This grouping may be difficult to maintain throughout the year owing to culling and replacements, but at least the birds should be grouped if a large number of pullets are placed in the cages at any one time.

Large-scale producers may retain the block grouping system throughout the year. In effect, each block of cages is regarded as a flock, and is so recorded and costed.

Pullets surplus to initial requirements are reared for each block. They may be kept on deep-litter, in yards or balcony units. They constitute the reserve pool from which replacement pullets are drawn.

Thus, culls in each block of cages are replaced by pullets of

[1] On several occasions it has been noted that battery [illegible]

the same age and breeding. Risks associated with moving reserve pullets in lay to cages are accepted. Moulting among the newcomers is not so widespread as may be supposed, due to the very favourable environment of a well managed battery plant.

Replacement of culls is usually restricted to the first few months of the pullet year, thereafter the number of birds in each block of cages is gradually reduced by normal wastage as the laying term draws to a close.

Scouring in Batteries. When the birds are moved to the cages the droppings may be loose for a time. This is due to the change of feeding and perhaps environment, and as a rule the condition becomes normal in the course of a few days if a suitable ration is being fed.

Some feed oats in addition to mash or pellets for a short time after pullets are placed in the cages. Since most growing pullets have a mash-grain diet, temporary feeding of oats will make the change to a battery diet less drastic and will help to prevent diarrhœa.

The droppings of battery birds are usually looser than those of birds kept on other systems, but scouring will not occur if a properly balanced ration is fed and housing conditions are satisfactory.

Complaints of scouring in batteries were at one time very prevalent. Much of the trouble was due to improper feeding, but perhaps the greatest cause in the earlier days of the battery was lack of ventilation in the house. Birds kept in a vitiated atmosphere are bound to become debilitated, their whole system loses "tone"—hence diarrhœa more or less severe.

Should scouring persist, feeding should be considered; it is equally important to consider housing conditions. If the latter are satisfactory probably a slight alteration in the composition of the ration will effect a cure.

Individual birds may continue to pass loose droppings while remaining in lay and in good health.

Occasionally scouring may occur in a section of the battery or even throughout the battery house, for no apparent reason. Except for diarrhœa, the birds show no symptoms of ill health and continue to lay at a normal rate. Cases of this kind clear up in due course without treatment.

In some instances the addition of 1 or 2 per cent of vegetable charcoal has proved effective. This amount should not be exceeded, and it should be fed for a short period only.

Birds that show greenish or yellowish diarrhoea and loss of appetite should be culled, as should any birds with symptoms of fowl paralysis. They should be sold for table while they are in sufficiently good condition for the purpose. If left in the cases they almost invariably lose weight rapidly and, of course, they may be a source of infection to others.

Feeding in Batteries. It is usual to feed an all dry mash or pellet ration in the battery house. The food is given *ad lib.*

Many claim that pellets reduce waste. This, however, is largely a matter of the design of the food troughs and the avoidance of over filling. The troughs should not be filled beyond about two thirds of their capacity, and should have a comparatively wide lip, to prevent the birds picking out the food.

In cafeteria batteries pellets should be fed to maintain an adequate intake of feed. Birds can consume a greater weight of pellets than mash in the limited feeding time—usually about 7 9 minutes per hour—which batteries of this type provide.

The diet must be correctly balanced for birds kept under battery conditions.

Grain is not usually fed to battery housed stock. If it is fed it may be given at any convenient time provided the amount is so restricted as to ensure a balanced diet with mash or pellets which should be suitably compounded for feeding with grain.

Wet mash is not recommended, but should the producer wish to use home mixed meals and is without a pelleting machine, supplementary feeds of wet mash may be required to maintain feed consumption at a high level. In that event it will be sufficient to dampen the surface of the mash in the troughs.

However, if it is desired to make use of boiled potatoes, processed house scraps (puddings) and similar waste foods, the birds should be given crumbly mash in the morning and again in the late afternoon, as much as they will clear up within a reasonable time at each meal. If the mash contains a high proportion of bulky material very great care [illegible] will be

given—sufficient to keep the birds occupied for two or three hours before the mash is cleared up With bulky mashes they must be given time to take a second or third helping should they require it.

Food Consumption in Batteries On the orthodox systems of poultry-keeping the average dry weight of the food consumed per bird per day is approximately $4\frac{1}{2}$ oz, or 28 lb per 100 birds

Photo Salopia Industries (Metals) Ltd

FIG 132—MECHANICAL FEEDING AND CLEANING

Power operated food hoppers move along the track, food falling into the troughs The amount of food can be regulated to provide *ad lib* or controlled feeding Feeding and cleaning are carried out simultaneously A portable power unit is connected to each block of cages in turn

Naturally, consumption is very variable, depending on whether or not the birds are in lay and to a lesser extent on the breed Laying birds eat much more than those not in lay, and heavy breeds eat more than light breeds—but for the present purpose $4\frac{1}{2}$ oz feed weighed dry may be taken as the average daily amount consumed by a laying bird

Feed required for maintenance of birds of different body weight and for egg production is discussed in Chapter Sixteen

In batteries food consumption is rather greater; it works out at about 5¼ oz. per bird per day or 2·2–2·4 lb. per week. In the full production period of 48 weeks total feed consumption is in the region of 1 cwt., i.e., 5 cwt. will feed about 240 birds for a week.

This estimate is given on the assumption that balanced diets of good quality are fed. If foods of inferior quality are used consumption will be substantially higher. High-energy diets result in improved feed-conversion efficiency.

If wet mash containing potatoes and other bulky vegetable matter is fed, a bird will eat some 10–12 oz. (weighed wet) per day.

Food consumption, however, must be related to egg production to obtain a fair comparison between the different systems. There is usually little difference in feed-conversion efficiency in batteries and under deep-litter conditions.

In general terms it may be said that these systems are about equal in this respect, but *food conversion efficiency of birds* kept on extensive systems is usually lower, i.e., they consume more food per dozen eggs produced than do birds kept on intensive systems.

This should be borne in mind in view of the alleged economy of feeding stock on range.

Grit and Shell. In batteries oyster-shell, cockle shell or limestone grit may be fed over the mash or pellets. A little should be scattered over the food from time to time. Provided some remains in the troughs, the birds will eat all they require. All these grits are equally effective so far as shell texture is concerned, therefore the cheapest should be fed.

Some prefer to use limestone flour instead of grit or oyster-shell. In that event it should be mixed with the food at the rate of 5 per cent of the weight of the dry mash, or about 5–6 lb. per bird per annum.

A little flint grit should also be given, equivalent to about 20 per cent of the weight of calcium grit or about 1–1½ lb. a year. Flint grit need not be supplied at frequent intervals. It is sufficient to give it about once a month, since it will then be retained in the gizzard, whereas when fed continuously excess of grit is passed out of the gizzard.

Battery birds should have ½ per cent of cod-liver oil or the

appropriate percentage of vitamin D3 concentrate in the food at all times of the year

Artificial Lighting in Batteries. Artificial lighting is commonly employed on commercial plants There is no doubt that it is an economic proposition, but great care should be taken not to give an excess of the "light ration" The lights should be suspended in the centre of the service passages, and should light the food and water vessels

It is immaterial whether artificial light is used in the morning or evening or both morning and evening In the battery house a dimmer switch is not required

Some plants are equipped with fluorescent lighting Although more expensive to instal than ordinary lamps, current consumption is lower

Artificial lighting of spring-hatched pullets may be expected to increase production during the six winter months by between twelve and fifteen eggs per bird, but it should be realized that this is at the expense of spring and summer production

Artificial light will usually effect a greater increase in autumn and winter egg production by early hatched pullets because it lowers the incidence of moulting at this season

Recording In the early days of the battery system it was customary to keep daily records of individual birds Record cards were attached to the cages or food troughs, one card being ruled to record three cages, i e, one in each tier

In some cages recording was accomplished by means of rings moved along a stout wire from one side of the cage to the other Starting with all rings on the left, when an egg was collected one ring was moved over to the right side of the cage

Thus at the end of the month the total production was ascertained by counting the rings

Others used clothes pegs on the wire floor extensions to indicate production Some merely marked the food trough with chalk as the eggs were collected

These methods are still employed, but not so widely as formerly On commercial plants daily individual recording serves little useful purpose, and has been largely abandoned Instead the birds may be recorded for short periods at certain

seasons only, e.g., just before Christmas and Easter or at any time average output is sub-normal

But even this short period recording has not universal appeal On many battery plants records are kept of the performance of birds in each block or group of cages, the batteryman relies on his observation and judgment to guide him in culling He notes the appearance of the birds, their appetites and the condition of the droppings

Individuals showing the characteristics of the poor producer, those birds which are obviously in poor condition and those with greenish diarrhoea are culled

Individual recording is impracticable in two- and three-bird cages now becoming increasingly popular

Those who favour keeping individual records will save time by recording the number of eggs collected to date instead of marking the cards with strokes or crosses to be totalled at the end of the month For example if a bird lays on the first day of the month enter 1 in the appropriate square, if she lays on the second of the month enter 2, if she does not lay on the third but lays on the fourth day enter 3 for that date and so on

When culling due allowance should be made for moulting and broodiness In these cases the commercial producer is guided by the production of the group the season and the length of time the birds have been in lay For instance, towards the end of the production year—usually ten to eleven months birds moulting or going broody would probably be culled whereas this behaviour early in the season would not warrant culling

It is not possible to follow arbitrary procedure in matters of this kind One must aim at securing the greatest profit That does not imply drastic culling without regard to other factors

Broodiness With birds of a high utility strain or cross broodiness will not be prevalent on the battery system Birds will go broody from time to time but as a rule they soon get over it, because the environment of the battery is not conducive to the [illegible] No treatment is necessary The birds should be left in their cages [illegible] normal ration [illegible]

[illegible] It can [illegible] be said that [illegible]

batteries is an unqualified success The bird usually drop their feathers at a remarkably rapid rate but in ery low con dition badly, and require many weeks or even months in which to recover They may be out of production for three months or more and this usually occurs during the season when egg prices are high

In the writer s experience it is not profitable to keep birds in cages over their annual moult Undoubtedly some in dividuals will pay to keep a second season, but unfortunately they cannot be identified at the completion of their first year in the cages

Generally speaking it is more profitable to replace the birds at the end of their first laying season If, however, it is desired to keep a proportion of second year hens the birds that main tain good condition and moult late in the season are likely to be the most profitable

The above remarks refer to the annual moult that takes place in the autumn

Young pullets taking a partial or even complete moult in the autumn or winter of their first year usually moult satisfactorily and it is not suggested that these birds be discarded , also this applies to pullets that moult in the spring These latter usually take a quick moult and under the influence of the lengthening days soon return to production

Insect Pests Insect pests can be very troublesome in battery cages All metal cages do not prevent them, it must not be assumed that because the birds are free from external parasites they will remain free in cages for this is not so

The birds should be examined for lice and the cages for red mites at frequent intervals throughout the year, but especially during hot weather *Red mites will congregate wherever* they can find seclusion—under mash hoppers droppings trays and even beneath droppings that adhere to the wire floors Modern insecticides applied as aerosols (an extremely fine spray) will quickly rid birds and plant of these pests

Egg Production The average egg production obtained from stock in batteries is usually higher than from birds kept on the more orthodox systems

Whereas a *pullet flock average of 15 16 dozen eggs per* bird is considered satisfactory on a well managed commercial farm

on the battery system it would be reasonable to expect an extra 1½ dozen eggs per bird. Instances of much higher production are common.

Thin-shelled Eggs. There is no doubt that the battery system is stimulating. This is shown by the fact that birds may occasionally lay two or even three eggs in the course of twenty-four hours, but when they do so the second and third eggs are usually thin-shelled or shell-less.

This trouble is more prevalent when young pullets are coming into production, and in the spring, when birds are laying at a rapid rate, because the ovary is in an extremely active condition. Yolks leave it in such rapid succession that the birds are unable to assimilate sufficient calcium to provide shells for all the eggs produced.

batch in March or early April.

It might be supposed that hatching all the year round would permit the battery-owner to keep his plant fully productive. In practice that is not possible, because however good the management there is always a proportion of the cages containing birds not in lay—young pullets not yet mature, birds that are moulting and broody, and those taking a temporary rest.

On a commercial plant it would be fair to say that, taking the year as a whole, some 15–20 per cent of the cages are unproductive for the reasons stated.

This percentage may seem rather high, but in fact it is lower than with any other system of poultry-keeping under equally good management, because with all other systems a higher proportion of unproductive birds will be kept, while it is not possible to keep flock houses as fully stocked as the battery house throughout the year.

Age of marketing the pullets should be related to average egg production and current egg prices; in short, to profitability.

Superior strains are capable of maintaining a high level of egg production for a laying season of twelve months or even rather longer, as the performance of pens of outstanding quality at laying trials has shown. This, of course, applies equally to birds kept on other housing systems.

Chapter Thirteen

Recording Systems

No farm can be efficiently managed unless proper records are kept. The poultry-man must keep the usual account-books in order to show his financial position, whether he is making a profit or loss and—what is of great importance—where the profit or loss is being made.

Photo: Modern Poultry Farmer

FIG. 133. NUMBERED LEG RINGS USED BY THE PEDIGREE BREEDER

The rings should be attached with the numbers upside down so that they can be easily read when the bird is handled. Coloured rings are commonly used for rapid identification in the run.

If the prospective poultry-farmer is without some knowledge of book-keeping, he should study an elementary text-book on the subject, or consult an accountant.

Apart from the books and other records concerned with financial transactions, he must use a proper system for recording the performance of his stock, without the information this reveals he is completely at a loss to know where to put his [illegible]

EGG PRODUCTION RECORD

YEAR PEN Nº Nº OF BIRDS DATE OF HATCHING BREED BREEDER

MONTH	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	TOTAL FOR MONTH	TOTAL TO DATE	REMARKS

FIG. 134.—EGG-PRODUCTION RECORD CARD

on the source of those innumerable leakages, perhaps not serious in themselves, but which collectively may make the difference between success and failure.

Many systems of recording are practised, but it cannot be said that of those found efficient one is superior to another. So much depends on the class of farm—*i.e.*, the requirements of the man at the head of affairs. A system that one man may regard as ideal may be considered inadequate or unnecessarily complex by another.

The following suggestions are not intended to represent an ideal, but rather to give a somewhat sketchy outline of the records required and a method of making them.

On the commercial farm little detail is required compared with the vast volume of data recorded by the pedigree-breeder. The former will be considered first.

Egg-production Records. For flocks that are not trap-nested a simple card on which the daily egg production is recorded will be sufficient. Each card should show the year, the number of the pen, number of birds in the house, the breed or cross, date of hatching, and the name of the breeder, with columns for monthly total and total to date. There should be a wide margin for remarks, on which should be recorded mortality and other items likely to be of value for reference.

A card for this purpose might be ruled as shown in Fig. 131.

The information at the top of the card should be recorded when the birds are housed. If the work is postponed, doubts may arise later.

Trap-nest Records. The card should record the egg production for one month. It may be ruled to correspond with the pen record, with the exception that the left-hand column should show the year and month, and, below, the number of each bird in the house.

On many cards the pen-number, breed, month and year are recorded on the top, other information being kept in the stock record book, in which the total production of the pen for each month is entered.

Incubator Records. At one time it was customary to keep a record of the morning and evening temperature of the incubator. This adds to the poultry-man's work and serves no practical purpose, because with efficient machines properly

housed there is little variation in temperature. Any wide departure from the normal temperature that may occur may be recorded, together with the reason, in a column for remarks at the side or bottom of the card.

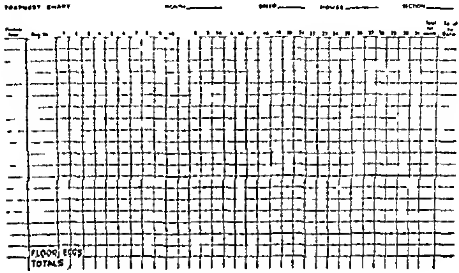


FIG. 135—TRAP NEST RECORD CARD

An incubator record card may be ruled as follows—

INCUBATOR RECORD

Incubator No	Date Set	Date Due
	Breed	Breeder
Hatch No	No of Infertiles	
	No of Chicks Hatched	
No of Eggs Set	No of Dead in Shell	
	No Removed to Brooder	

NOTES

FIG 136—INCUBATOR RECORD

These cards should be filed for reference.

Alternatively, the above information may be entered in an incubator record book, a card pinned over each machine being used to show date of setting, date of egg-testing and date of hatching. This card is merely for the convenience of the operator.

In cabinet incubation eggs should be set weekly, and each tray should be marked with a small card of distinctive colour to indicate the week—say, red for the first week, white for the second, blue for the third.

The cards should show the breed or cross, and should bear a number to correspond with that in the hatching book, where all other details required by the operator should be entered.

Brooder Records. All the information required by the commercial man can be recorded on a card ruled as below.—

BROODER RECORD

Brooder No		Breed	Date Hatched		No. of chicks
Hatch No					No. reared
Day	*Losses*	Notes	Day	*Losses*	Notes
1			22		
2			23		
3			24		
4			25		
5			26		
6			27		
7			28		
8			29		
9			30		
10			31		
to			to		
21			42		

No. of cockerels moved *Date*
No. of pullets ,, ,,

FIG. 137.—BROODER RECORD

Rearing Records. For the growing stage it is sufficient to enter across the top of the card the number of the pen, date of hatching, number of hatch and number of birds housed, the remainder of the card providing space for notes, on which should be recorded information with regard to *mortality*, *culling*, and perhaps the average weight of the birds if the rearer desires this information.

REARING RECORD

Pen No	Date of Hatching
Hatch No	No of Birds

NOTES

FIG. 138.—REARING RECORD

Pedigree Recording. Pedigree recording involves work of considerable detail. The task is an exacting one.

Many different systems are favoured, but all should ensure accuracy and simplicity, and should provide the fullest information available at a glance.

The card-index system is favoured by many pedigree breeders. It has much to recommend it, provided it is applied on business-like lines. All cards should be kept in their respective filing cabinets. They should be removed only when required, and should be immediately replaced. This advice may seem to state the obvious, but in fact carelessness when handling records frequently leads to odd cards being lost, and that is a serious matter for the pedigree breeder.

Pedigree recording starts with the trap-nest record card of each bird. The number of the hen should be written on the broad end of the egg at the time the bird is released from the trap-nest. In recording the egg many breeders use letters to indicate the grade, entering "A" on the card for a "special", "B" for a standard, "C" for a second and "D" for a pullet egg.

The total and grade records are entered at the end of the month on the right of the card, the information being carried forward to the left side of the card for the following month.

Egg Cabinet. An egg cabinet is essential on the pedigree farm It consists of a number of trays with 1½-in. holes drilled in the bottom to hold the eggs in a vertical position They should be stored with the broad end upwards.

The size of the trays is not standardized Much depends on the details of the system preferred by the breeder. It is,

however, convenient to have the trays eight to ten holes deep—*i.e.*, from front to back—with about the same number of holes from side to side. The rows of holes should be numbered to correspond with the number of the hen; thus each tray will hold all the eggs produced by eight to ten hens in as many days.

Each tray may bear the pen-number and other details the breeder may wish to record.

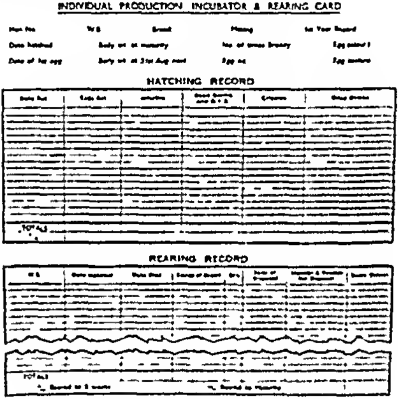


FIG. 139—PEDIGREE HATCHING AND REARING RECORD

Pedigree-hatching Record. The pedigree-hatching record should show the number of the hen, the number of the sire, the hen's first-year egg production, egg-weight, body-weight, number of times broody and other information required by the breeder. This should be recorded at the top of the card or page in the hatching-record book as may be, and below it should be ruled for showing date of setting, number of eggs set, number of infertiles, number of dead in shell, total number of chicks and number of chicks of good quality hatched.

Rearing Record. The rearing record, which may be printed on the back of the hatching-record card, may be ruled as shown.

Male Hatching and Rearing Record. It is desirable to have the breeding record of the male readily available. This may be accomplished by recording the information shown on a card ruled as in Fig. 140.

MALE HATCHING AND REARING CARD

Cock No.: W.B.: Breed: Mating:

Date Hatched: Wt. at Maturity: Wt. at Aug. 31st. next:

EGG No.	EGGS SET	INFERTILE	[illegible] AND [illegible]	CRIPPLES	GOOD CHICKS	DOWN COLOUR	DEAD TO 8 WEEKS	DEAD 8-16 WEEKS	TOTAL REARED
TOTAL									
%									

FIG. 140.—MALE HATCHING AND REARING RECORD

Progeny Testing. For progeny testing a card ruled as follows will be found to give the information required.

PROGENY CHART

Breed: MALE No. Dam's record YEAR:
Dam's age at first egg

Hen No.	Age at 1st Egg	Prod.	Daughter No.	Age at 1st Egg	Prod.	Daughter No.	Age at 1st Egg	Prod.	Daughter No.	Age at 1st Egg	Prod.	Daughter No.	Age at 1st Egg	Prod.	Av. Age at 1st Egg	Av. Prod.	Remarks

FIG. 141.—PROGENY RECORD

On the reverse side provision should be made for recording the description and pedigree of hen, thus:—

DESCRIPTION AND PEDIGREE

Hen No ....

Head	Eye
Shanks	Plumage
Type	Down Colour
Body wt.	Dam's Body wt.
Sire's Body wt.	Sire's Dam's Body wt.

REMARKS:

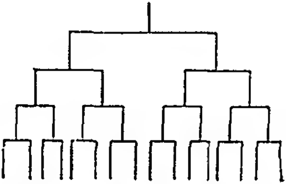


FIG. 142.—DESCRIPTION AND PEDIGREE RECORD

Photo: Modern Poultry Keeping

FIG. 143.—PEDIGREE RECORDING.

Recording the eggs as they are placed in the pedigree hatching trays

Photo Modern Poultry Keeping

FIG 144 —ANOTHER "PEDIGREE JOB"

When in the incubator individuality of the eggs has still to be maintained by means of pedigree cages, extensive booking etc Photo shows recording eggs before loading the incubator

Photo Modern Poultry Keeping

FIG 145 —PEDIGREE WORK

On the completion of the hatch chicks are removed from the compartments of the pedigree-egg trays to separate well littered day-old-chick boxes so that they shall not get mixed with others.

Photo: Modern Poultry Keeping

FIG. 146.—WING BANDING A DAY-OLD CHICK

Photo: Modern Poultry Keeping

FIG. 147.—RECORDING YOUNG STOCK

[illegible]

All the information a breeder requires with regard to the male birds may be recorded on a card ruled as follows:—

COMPLETE MALE RECORD

COCK	No.:	Date Hatched	W.B.	Breed	Body Wt.:
Dam's No.		Dam's [illegible] Aug. 31st [illegible]	Sire's Dam's Production		Sister Av. Production
Dam's Age at 1st Egg		Dam's No. of times broody	Sire's Dam's Egg wt.		Sister Av. Egg wt.
Dam's Production		Dam's Egg wt.	No. of Sisters		Sister Av. wt. at 1st Egg

YEARS				
Number of hens in pen — — —				
Number of egg set — — —				
Number of infertiles — — —				
Number of dead germs and D.I.S. —				
Number of cripples — — —				
Number of good chicks — — —				
Down colour of chicks — — —				
Number died in 1st 8 weeks — —				
Number died in 8-24 weeks — —				
Number reared — — — —				
Pullets kept — — — —				
Cockerels kept — — — —				
Daughters av. age at 1st egg — —				
Daughters av. production — —				
Daughters av. egg wt. — — —				
Daughters av. times broody — —				
Mothers av. age at 1st egg — —				
Mothers av. production — — —				
Mothers av. egg wt. — — —				
Mothers av. times broody — —				
Number of daughters died in pullet year				

FIG. 148.—COMPLETE MALE RECORD

Many of the above charts are based on American practices. They show the lines on which the pedigree-breeder may keep his records, but of course they may be modified to suit the requirements of individual breeders.

It should be emphasized, however, that while some of the information to which reference is made in the above charts may not be recorded, simplification cannot be carried very far if the pedigree record is to retain its usefulness.

In modern practice the egg production of the dam and the sire's dam, although important, do not constitute a pedigree.

The real pedigree-breeder demands much more detailed information, and it is essential to obtain as complete a picture as possible of the breeding value both of individuals and their families if progress is to be made along the hard road leading to stock improvement.

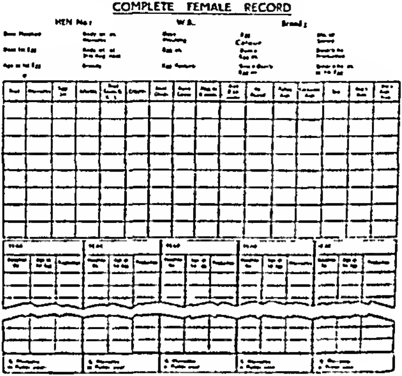


FIG. 150.—COMPLETE FEMALE RECORD

Chapter Fourteen

Reproductive and Digestive Systems of the Fowl

The Reproductive System of the Male. The reproductive system of the male consists of two testes which lie close to the backbone and near the front end of the kidneys. In young birds they are very small, but when mature they develop to a considerable size, being about 2 in. long and nearly 1 in. in diameter. They are yellowish-white in colour, and more or less the shape of a bean. The left testis is usually a little larger than the right. From each arises a small tube, called the vas deferens, which carries the seminal fluid to the cloaca, from which it is ejected at the time of copulation.

The Reproductive System of the Female. In early embryonic life the female has two ovaries, the left and the right, but normally only the left one develops. This is located high up in the abdominal cavity and well forward towards the thorax.

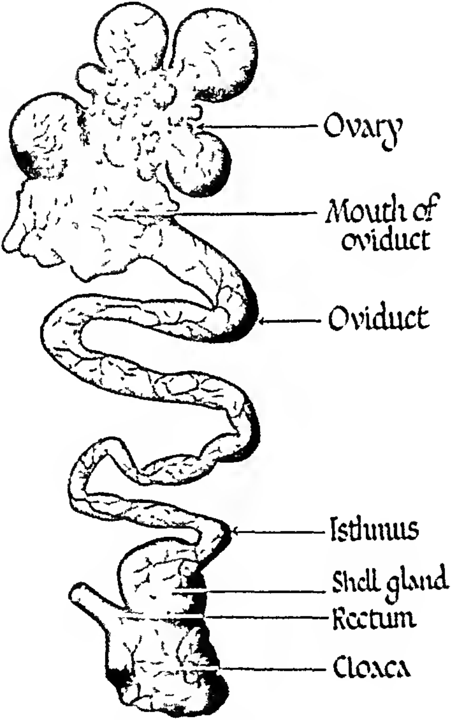
It is from the ovary that the yolks or ova arise. If a bird in lay is killed and the ovary examined, it will be found to have ova in various stages of development, from the rudimentary ova, which have the appearance of small, yellowish beads, to the mature ova as seen in eggs.

It is interesting to note that in the chick the number of ova may vary from 3,000 to over 4,500.

Each ovum is enclosed in a thin membrane or follicle attached to the ovary by a thin stalk.

When the ovum is mature it is released from the follicle and falls into the body cavity, from which it is picked up by the free end of the oviduct. It then begins its passage to the cloaca. The muscular contractions of the oviduct carry the ovum along its length, and during the process it receives layers of albumen, the chalazæ (the thick coils of albumen), the shell membranes and finally the shell, the latter being formed in the vagina.

Yolks in Abdominal Cavity. Occasionally the vitelline mem-


Ovary
Mouth of oviduct
Oviduct
Isthmus
Shell gland
Rectum
Cloaca

[illegible]

brane, which surrounds the yolk, ruptures while the ovum is in the body cavity, and the mass spreads and lines the peritoneum In this condition it cannot be picked up by the oviduct, and the material hardens, becoming a semi solid mass

Further yolks may accumulate in this way When found on post-mortem examination these masses of yolk are commonly described as "egg tumours"

Abnormal Eggs *Blood spots* Blood spots in the yolk are a comparatively common defect in eggs Most of them arise through intra-follicular hæmorrhage while the ovum is still in the follicle, and not, as popularly supposed, through rupture of blood vessels when the follicle splits Blood spots in the white are caused by the rupture of a blood vessel in the oviduct at the time the yolk is passing through it

Blood spots vary in size from a small speck to a large blob Occasionally there may be found an egg that appears to be full of blood, so much having escaped from a ruptured blood vessel

Although eggs having small blood spots are edible, they should not be marketed, for two reasons (1) they lower the standard of the consignment, and (2) should they reach the consumer he will have just cause for complaint

Blood spots are more common in the spring, when the ovary is very active, and therefore plentifully supplied with blood They are also more likely to occur when flocks of young pullets are starting to lay Usually the trouble disappears when the ovary becomes less active There is no treatment

It has been shown that the tendency to produce blood spots is inherited and that it is possible to reduce the incidence by selection But in practice this would not be justified, the breeder should concern himself with more important matters

Meat spots Meat spots are commonly supposed to be small pieces of tissue from the ovary or oviduct Microscopical examination has shown that in most instances they consist of blood spots the peculiar appearance being due to degeneration of the blood included in the egg

New laid "Bad" Eggs Very occasionally a new laid egg is found to be inedible, the contents being more or less solidified This is due to the egg having been held up in the oviduct for a considerable time

Davies isolated from affected eggs a pigment distinct from the normal yolk pigments, and showed that this pigment was a chlorophyll derivative

Trouble of this kind can be avoided by providing a diet adequate in quantity and quality

Acorns Fresh acorns may result in olive green yolks if they contain gallic acid or tannins, which produce the acid during the process of digestion Work by Temperton showed that germinated or cooked acorns produce this defect through the hydrolysis of acorn gallotannins to gallic acid The latter combines with the yolk iron to form ferric gallate, which causes the discoloration When fully ripe ungerminated acorns were fed Temperton (1943) found no discoloration of the egg contents, even when the daily quantity of acorns comprised 3 oz per head

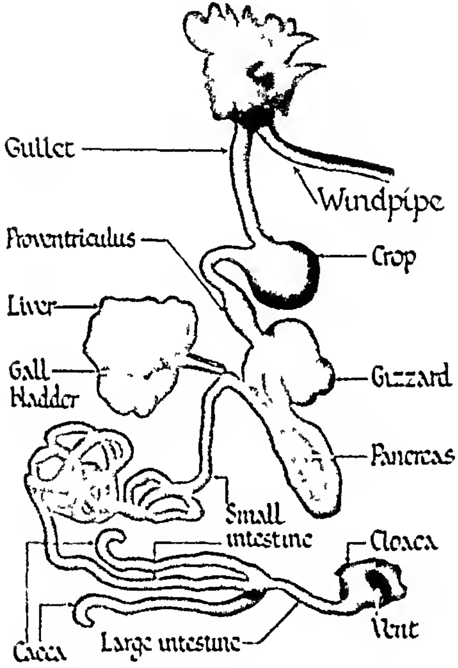
The writer fed up to 2 oz of dried acorns daily to pullets kept in total confinement This caused no discoloration of the yolk

Oak Sawdust Eggs having olive coloured yolks may be produced by flocks kept in total confinement Complaints of this kind are rare In addition to the above mentioned factors the consumption of oak sawdust litter may be responsible In some cases it has been necessary to replace the litter owing to its containing oak sawdust which caused yolk discoloration

The Digestive System of the Fowl The digestive system of the fowl differs markedly from that of mammals The mouth cavity is formed by the upper and lower beak, which correspond with the jaw bones of animals Fowls have no teeth The tongue is pointed like an arrow and rather hard When food is picked up it passes rapidly to the back of the mouth, where it enters the gullet or oesophagus leading to the crop, a relatively large, pear shaped pouch

Crop In the crop the food is softened by the secretions of mouth and gullet, and is prepared for digestion The crop does not secrete digestive juices, but some digestive action is derived from the saliva swallowed with the food and ferments present in the latter It is a food store from which the gizzard is supplied

The crop is connected by a short tube, through which food passes to the proventriculus or true stomach Here it is mixed


Gullet
Windpipe
Proventriculus
Crop
Liver
Gall bladder
Gizzard
Pancreas
Small intestine
Cloaca
Vent
Caeca
Large intestine

with the digestive juice containing hydrochloric acid and pepsin, a ferment concerned with the digestion of proteins. Food is not retained in the proventriculus as in the crop.

Gizzard. Beyond the proventriculus lies the gizzard, a highly muscular, hollow organ having thick walls lined with horny membranes. By slow expansion and contraction the gizzard grinds and crushes the food, which is soon reduced to fine particles. This process is assisted by the presence of grit.

There has been much controversy with regard to the advisability of supplying fowls with insoluble grit. Many have stated that it is entirely unnecessary. There is no doubt that the stock may be kept in health and production without it, but a number of investigators have shown that the provision of insoluble grit results in more effective utilization of the food, and for this reason its use is fully justified on economic grounds.

When a normal diet is fed the gizzard has a strongly acid reaction, which not only assists digestion but is also of value in the destruction of certain pathogenic organisms (Williams Smith, 1954).

Intestine, Pancreas, and Liver. Extending from the gizzard is the long tube in many coils which forms the small intestine. The first loop is called the duodenum, and in this loop lies the pancreas. Both the pancreas and the liver are connected with the small intestine by a series of small ducts, through which flow the juices from these two glands.

The pancreas secretes the pancreatic juice, which contains a number of enzymes. These assist in the breaking down of the food constituents.

The liver, by far the largest gland of the body, secretes bile, which flows through ducts to the intestine. Close to the liver lies the gall-bladder, in which the bile is temporarily stored. The bile emulsifies fats, which are then broken down by enzymes.

Lining the inner surfaces of the small and large intestines are innumerable projections called "villi", through which food—now in the form of a nutrient solution—is actually absorbed and carried by the blood-stream, in which it circulates throughout the body.

Cæca. Two blind pouches—or blind guts—enter the intestine at a point that marks the division between the small and large

Chapter Fifteen

The Principles of Poultry Feeding

BEFORE poultry-keeping became a great industry, little thought was given to nutritional requirements of the birds. They were kept under conditions where they could obtain a wide variety of foodstuffs—an assortment of grains, grasses and other vegetable foods, grubs and insects of all kinds. In these circumstances they could balance their own ration.

In those days the need for rapid growth, high egg yield and for the production of eggs and meat as economically as possible under conditions very different from those provided by Nature did not arise.

To-day circumstances are entirely different. If poultry-keeping is to be an economic proposition it is essential to ensure rapid growth and a high rate of laying at the lowest possible cost. Moreover, in the modern poultry industry birds are frequently kept under conditions in which they are entirely dependent on the food supplied to them; they cannot supplement their ration with Nature's tit-bits. Sometimes they do not receive sufficient direct light, and cod-liver oil or other good source of vitamin D must be provided to prevent the development of rickets.

It is largely owing to the result of the evolution of the intensive system that research workers have been able to study the manifold problems of poultry nutrition. If the birds could not be kept in total confinement it would not have been possible to ascertain their requirements to the extent that they are known to-day; indeed, little progress could have been made.

The poultry-man must understand the fundamental principles of nutrition in order to feed his birds economically. Years ago rations were compounded with little regard to the actual requirements of the birds. Even down to comparatively recent times efforts were largely designed to avoid possible deficiencies, and this, owing to lack of knowledge, commonly resulted in feeding large amounts of certain nutrients, par-

ticularly proteins, vitamins and minerals. The general belief was that by feeding these foodstuffs in excess the birds would take what they required and Nature would get rid of the surplus. To some extent that is correct, and it is fortunate that this is so because the stage has not yet been reached when the actual requirements for all essential food factors can be calculated with accuracy. Indeed, this stage cannot be expected, because individual birds differ in their needs. In making sure that the ration was not deficient, certain foods were often fed in excess. This not only resulted in wasteful feeding, but in some instances the effect was extremely injurious, or even fatal.

To-day it is imperative to keep the cost of egg and table-poultry production as low as possible, and, since feeding usually represents some 60 or 70 per cent of the total cost of the former and 70 per cent of the latter, the composition of the diet must be carefully studied with a view to effecting economy.

It should be emphasized, however, that the true value of a feeding-stuff cannot be assessed by its initial cost. The measure of its worth can be determined only by its effect on the cost of producing the egg or the table bird, as the case may be. As a general rule, so-called cheap feeding-stuffs prove to be expensive because while they reduce the cost of the diet they usually increase the cost of production.

Essential Nutrients. Food is the fuel of the body. It enables the vital processes to be carried on. It provides material for growth, for the maintenance of the body and, with poultry, for the manufacture of the egg. The body may be regarded as a chemical laboratory where foodstuffs are converted into heat, energy, flesh and other tissues. The laying hen uses the food surplus to these requirements for egg production.

When the ration provides sufficient nutriment to maintain life, it is called a "maintenance ration"; when it furnishes a surplus for production, a "production ration".

The essential nutrients which the diet must provide are:—

(1) Water
(2) Carbohydrates (starch, sugar, fibre).
(3) Fats
(4) Proteins and similar nitrogenous compounds
(5) Mineral substances
(6) Vitamins (accessory food factors).

Water. Although water is commonly regarded as distinct from the food, it is an essential part of the diet Water plays a highly important role in all body processes, and a constant supply must be available to the birds Lack of water will quickly arrest the growth of young stock and check production of the layers Birds will soon stop laying if they are deprived of drinking-water—much sooner, in fact, than if they are deprived of food They can survive for weeks without food, but they will die in a few days without water

Water constitutes a large proportion of the body and of the egg About 60 per cent of the former and 65 per cent of the latter consist of it

Water is essential for the absorption of food, being the vehicle that distributes nutrients throughout the body and carries away waste products

It assists in the preparation of food in the crop, gizzard and other parts of the digestive tract, it maintains the proper consistency of the blood, it is the principal constituent of mucus—the body's lubricant—and it controls the body temperature by evaporation in lungs, air sacs and skin

Despite the fact that it plays so many parts in physiological processes, it is the simplest of all compounds normally employed in nutrition, and incidentally it is the cheapest

Carbohydrates This term covers a large class of substances, including sugars, starches, fibre, cellulose and many other compounds Carbohydrates are composed of hydrogen, oxygen and carbon, the two former elements being present usually in the same proportion as in water

They are abundant in plants and seeds Carbohydrates, usually in the form of starch, constitute a large proportion of the birds' food They provide heat and energy, and are used in the production of fat, which is stored in the body Carbohydrates are abundantly supplied in cereal grains and offals, potatoes and other foods of vegetable origin There is rarely any shortage in the poultry ration—the danger usually lies in feeding an excess

Sugars are also found in some common feeding-stuffs, a well known example being lactose in milk

In tables of analyses carbohydrates are frequently included in the expression "nitrogen-free extract" This fraction is

obtained by deducting the total percentage weight of water, ash, fibre, fat and crude protein in the food from 100

Starch Equivalent This term is commonly used as a basis for the comparative evaluation of feeding stuffs Production starch equivalent of a food is the number of pounds of starch required to produce the same amount of fat in the animal body as 100 lb of the particular feeding stuff For example, the starch equivalent of an average sample of middlings is about 69 which means that 100 lb of this feed has the same value for fattening as 69 lb of digestible starch

Fibre This is present in most feeding stuffs Crude fibre consists principally of cellulose, which in ruminants is broken down in the course of digestion It is of very little value to poultry because the food passes rapidly through the digestive tract, and so bacteria do not play an appreciable part in digestion, as they do in animals Nevertheless, some fibre is digested, while its effect on the physical condition of the food must not be overlooked

A distinction must be made between fibre and bulk A food stuff having a high fibre content is not necessarily bulky, while a bulky food is not necessarily high in fibre For example, some samples of oat husk meal, pea haulm meal and similar feeding stuffs which may have a fibre content exceeding 30 per cent will have the appearance of fine meal when ground in a modern high speed steel mill, whereas broad bran of good quality having a fibre content of about 10 per cent is an extremely bulky foodstuff

The amount of crude fibre that may be included in the diet without affecting growth and egg production is a matter of practical importance

*Many of the cheaper feeding stuffs contain a high per*centage of fibre and when using them an excess may be provided The higher the fibre content of the food obviously the lower its nutritional value and if fibre is fed at a high level it may be impossible for the birds to consume sufficient weight of food to obtain adequate nourishment

From the results of experimental work at a number of centres it would seem that the fibre content should not exceed 5½ per cent for chicks between 6 and 7 per cent for growing pullets and not more than 8 per cent for adults

These levels should be regarded as maximum More ... icient production will be obtained with chick diets contain... g between 4 and 5 per cent fibre, with growers diets between ... and 6 per cent, and layers diets also with 5–6 per cent

In recent years so-called high-energy diets have been fed, ...incipally for table-poultry production Their fibre content ... low, usually between 2 5 and 3 5 per cent, and in some diets ...ed in America stabilized animal fats are included at the rate ... about 2–4 per cent, still further to increase the energy value

When diets containing a high percentage of fibre are fed, ...e chemical composition of the fibre- and nitrogen-free ...xtract are matters of importance

Senior (1948) pointed out that a high percentage of ground ...ats was included in the chick diet without serious ill effects, ...hereas similar amounts of wheat pollard (wheat offal from ...5 per cent extraction wheat), although showing about the ...ame amount of fibre (10 per cent), caused a mortality from ...0 to 100 per cent before the age of four weeks

It is necessary to differentiate between fibre which has a ...redisposition to swell when wetted—*e g* , fibre of bran, grass ...meal, linseed meal—which is physiologically useful in stimulat...ng peristalsis (bowel movement) and preventing intestinal ...tasis, and non-swelling fibre such as oat, barley, rye which is ...physiologically inert and at high levels can cause impaction.

Fats Fats belong to a group of substances known as hydro...carbons They are compounds of hydrogen, oxygen, and car...bon, the proportion of oxygen being lower than in carbo...hydrates If solid at normal temperature, they are referred to as fats, if liquid as oils

Fats may be of plant or animal origin, but whatever their source they must be emulsified and broken down into fatty acids and glycerol before they are absorbed and reconstituted in the body

Fats provide energy in the same way as carbohydrates, but, as they contain less oxygen, they furnish about 2¼ times more energy than carbohydrates Fats, which must be stabilized to prevent rancidity, may be added to the mash at the rate of 5–6 per cent They could be employed at this level to raise the energy value of diets for all classes of poultry, but are not commonly included in diets other than for broiler chicks

Very high levels of fat have been used successfully in experimental work; in practice 4–5 per cent is about maximum, while 1–2 per cent is usually adequate, even in high-energy diets, since energy should be derived mainly from carbohydrates.

Cholesterol is a fat-like substance found in the blood of animals. Ergosterol is found in plants. These substances are of interest because when exposed to sunlight or ultra-violet irradiation and absorbed by the body they provide vitamin D.

Fat is stored under the skin, in the abdomen and other parts of the body. It is a reserve of energy.

Proteins. Proteins are organic compounds containing carbon, hydrogen, oxygen and nitrogen. They may also contain sulphur, phosphorus and iron, but the presence of nitrogen is a characteristic feature.

Proteins are an essential constituent of muscle, flesh, blood, and animal and plant cells. They are complex substances, which are broken down by the body processes and must be constantly replaced.

They contain approximately 16 per cent of nitrogen, and therefore in order to calculate the amount of protein present in any substance the analyst first estimates the nitrogen content and then multiplies the figure by 6·25 (100 divided by 16 equals 6·25).

The result, however, is not strictly accurate, because all the nitrogen may not be present in the form of protein and all proteins do not contain precisely 16 per cent of nitrogen. Therefore the result is expressed as "crude protein". It is possible by analysis to determine the amount of true protein present in the total crude protein, but for practical purposes tables of analysis usually show the percentage of crude protein only.

Proteins are of many kinds and appear in many different combinations.

Thus those of egg-white consist of 70 per cent albumin, 13 per cent of mucoid, others being globulin, conalbumin and mucin. The proteins of the yolk are vitellin and levitin.

It has been found in feeding experiments that proteins differ in their nutritional value, and that their value is not constant, depending not only on the level at which they are fed, but also on the nature of other proteins present in the feed.

It is, in fact, as important to consider the quality of protein concentrates as their quantity

The value of different proteins is associated with the presence or absence of certain amino acids, for this reason it is frequently advantageous to feed mixed proteins rather than to rely on a single protein concentrate

This is explained by the fact that in the course of digestion proteins are broken down into simpler compounds—amino acids—which in turn are converted into animal proteins Amino acids, however, are not of equal value, and the feeding of a second protein may supply the amino acids lacking in the first

There are many amino-acids, but only the following are regarded as essential under normal conditions arginine, histidine, leucine, isoleucine, lysine, methionine, phenylalanine, threonine, tryptophan and valine

These amino-acids should be adequately provided in all diets of average composition used in this country, and there is no need for the practical poultry man to make a specific study of them

When, however, the protein content is derived mainly from soya-bean meal and other plant sources and from meat and bone meal there is some risk of a deficiency of the sulphur amino acid methionine

When such rations are fed, and particularly if they are of the high energy type, they may fail to provide sufficient for the chicks' requirements In these circumstances the ration should be supplemented with synthetic DL methionine or a methionine rich foodstuff, such as fish meal, should be included in the diet

This also applies to diets for growing, laying and breeding stock if supplementary protein is derived largely from soya bean or earth nut meal

When compounding the diet it is necessary to consider not only the amount of protein rich foods but also the nature of the proteins or, as is commonly termed, their biological value It is possible to make up a diet having a high protein content and yet one that is wholly unbalanced unless the right kinds of proteins are included

Proteins of fish, milk and meat are of very high value, whereas proteins of vegetable origin are not usually equal to them A

mixture of animal and vegetable proteins is commonly used in rations to-day.

It must not be assumed that all vegetable-protein supplements are inferior in nutritive value to those of animal origin—*e.g.*, blood meal is inferior to expeller-process soya-bean meal. The value of protein supplements depends on their amino-acid constitution.

The optimum percentage of total protein of suitable quality that should be included in the diet depends to a considerable extent on the class of stock and the purpose for which it is being fed.

For maximum economic growth in pullet chicks to eight weeks old the diet should contain about 18–20 per cent of protein, for growing stock 14–15 per cent and for laying and breeding stock 15 per cent.

There is evidence that up to 24 per cent protein in diets from day-old to eight weeks promotes increases in growth rate compared with lower levels. Modern broiler chick diets contain about 22–24 per cent protein.

Albuminoid Ratio. Years ago considerable value was attached to what is known as the albuminoid ratio of a foodstuff—that is to say, the ratio of digestible albuminoids (proteins) to carbohydrates and oil. This is obtained by multiplying the percentage of oil the food contains by $2\frac{1}{4}$ (the assumption being that oil is about $2\frac{1}{4}$ times as valuable as carbohydrates), adding this figure to the percentage of carbohydrates and dividing the total by the percentage of protein. Wheat, for example, containing approximately 10 per cent digestible protein, 64 per cent carbohydrates and 1·2 per cent oil shows an albuminoid ratio of 1 : 6·6, calculated as follows:—

$$\frac{64 + 1{\cdot}2 \times 2\frac{1}{4}}{10} = \frac{64 + 2{\cdot}8}{10} = \frac{66{\cdot}8}{10} = 1 : 6{\cdot}6.$$

proteins or the presence of other essential constituents, including vitamins and minerals.

In recent years, however, something akin to the albuminoid ratio has been shown to be of importance in assessing the efficiency of the diet. This approach to the formulation of poultry diets is known as the energy–protein or Calorie–protein ratio, which expresses the Calories of productive energy per lb. of feed for each 1 per cent protein in the ration. One Calorie = 1,000 calories.

It has been shown (Combs, 1955) that rations containing high-energy levels must also contain relatively high levels of other essential nutrients if the balance of the diet is to be maintained and therefore food most efficiently utilized.

Since protein concentrates are the most expensive of the food constituents, and productive energy, which is mainly supplied by cereals and cereal meals, the cheapest, it follows that the Calorie/protein (C/P) ratio should be such as will ensure that the full value of both the energy and protein fractions of the diet will be obtained.

Studies at the University of Maryland indicate that in table-poultry production about 42 Calories of productive energy per lb. of food are required for each 1 per cent protein in the starter diet and 48–50 Calories for each 1 per cent protein in finishing diets.

Tentative energy : protein ratios recommended by New York State College of Agriculture (1959) based on information from studies at Cornell, Maryland and other experimental stations are summarized in Table 29.

TABLE 29

*Estimated Energy: Protein Ratio * for Different Classes of Poultry (New York State College of Agriculture, Cornell University, 1959)*

Type of diet	Estimated protein energy ratio
Chick starter (0–4 weeks)	41–43
Chick starter (0–8 weeks)	44–46
Pullet grower (8 weeks to maturity)	54–56
Layer and Breeder	
Large strains 5 lb or more at maturity	60–63
Small strains 4 5 lb or less at maturity	56–59

* Calories of productive energy per pound for each 1 per cent protein

required to rear a pullet when a high energy diet is fed compared with one of low energy

Theoretically the level of all nutrients in the diet should be adjusted with any change in the energy protein ratio because food consumption will vary (within limits) inversely with the amount of energy provided

TABLE 32

Productive Energy Value of Feeding stuffs (Texas Agric Expt Station Bul 678 (1946) by G S Fraps)

	Productive energy (Cal /lb)
High energy feeding stuffs	
Fats and oils	2 100
Maize	1 145
Kaffir grain	1 076
Wheat	1 024
Wheat red dog flour	1 020
Medium energy feeding stuffs	
Fishmeal	898
Corn distillers dried solubles	853
Corn gluten meal	839
Heavy oats	817
Barley	811
Meat scrap	734
Peanut meal	731
Wheat flour middlings	720
Low-energy feeding stuffs	
Soya bean meal expeller	661
Cottonseed meal	659
Light oats	642
Wheat standard middlings	581
Soya bean meal solvent	565
Dried whey	490
Wheat bran	478
Alfalfa meal	261

In practice, the average diet contains sufficient excess over minimum requirements that adjustment in the amount of other ingredients is usually unnecessary, with the exception perhaps of diets composed largely of cereals and vegetable proteins when the percentage of available phosphorus may become sub optimal if the energy value is markedly increased

Productive and Metabolizable Energy Productive energy values are most commonly used in estimating energy–protein relation ship, but since metabolizable energy values are more accurate indication of the energy derived from feedingstuffs, it seems

probable that in future the latter will be accepted as the standard on which diets will be based.

The productive energy of a foodstuff is the amount stored in the body as fat and protein by growing birds or that used for egg production.

Metabolizable energy value is the total energy or the number of Calories a foodstuff yields on burning, less the energy voided in the fæces and urine.

Table 33 on p. 409 shows the metabolizable energy of some common foodstuffs.

Digestibility. The digestibility of a food refers to the amount absorbed by the system, or the percentage of the food consumed that does *not* appear in the droppings. This is known as the digestion coefficient.

It might be supposed that this is a reliable indication of the value of the food, but coefficients that have been worked out in this way do not reveal the true value of a foodstuff.

Mineral Substances. Minerals play an important part in nutrition. They are essential for the maintenance of body processes, and due regard must be paid to the mineral balance of the ration to ensure good health and production.

Excess of one substance will not compensate for a deficiency of another; on the contrary, birds may be further deprived of a mineral already in short supply by the addition of another mineral to the ration. This is because chemical reaction takes place within the body.

Many of these substances are necessary in the diet of the fowl, but with few exceptions they are required in such small amounts that the average ration will supply them in adequate quantity.

Essential minerals include calcium, magnesium, manganese, sodium, potassium, iron, chlorine, iodine, phosphorus, sulphur and copper.

Of these by far the most important from the poultry-man's point of view is calcium. It is an essential constituent of the bones, the egg-shell consists almost entirely of it (in the form of calcium carbonate), and it plays a part in the clotting of blood.

Phosphorus, as phosphates of calcium and magnesium, is essential for the development and maintenance of the bones; iron is an essential constituent of the blood; sulphur is f[illegible]

in the egg and many body proteins, chlorine is present in hydrochloric acid of the digestive juices, iodine is necessary for the normal functioning of the thyroid gland, sodium,

TABLE 33

Metabolizable Energy Values of Common Feedstuffs of Chickens (F W Hill, 1959, Cornell University, Ithaca, New York)

Feedstuffs	Metabolizable energy average (Cal /lb)
Corn	1 560
Hominy feed	1 300
Milo	1 480
Wheat	1 500
Wheat red dog	1 250
Wheat flour middlings	1 200
Wheat standard middlings	820
Wheat bran	520
Oats	1 190
Oat hulls	150
Barley	1 290
Barley hulls	350
Rye (Tetrapetkus)	1 310
Molasses (Blackstrap)	890
Soybean oil meal (44%)	1 020
Soybean oil meal (50%)	1 150
Corn gluten meal	1 510
Meat scrap (50–55%)	900
Fish meal (Menhaden)	1 350
Corn distillers solubles	1 320
Dried whey	830
Alfalfa meal	620
Feed grade tallow	3 230
Hydrolysed fat	3 230
Fish oils	3 660
Soybean lecithin	3 060
Soybean soapstock	3 150
Pure beef tallow	2 860
Lard	3 980
Degummed soybean oil	4 210

The data have been calculated to an air dry basis assuming 10 per cent moisture for all ingredients except corn (15 per cent) molasses (20 per cent) whey (5 per cent) meat scrap fish meal and corn distillers solubles (7 per cent) and fats (moisture free)

potassium, calcium and magnesium are necessary for muscular action, and manganese for growth and for the prevention of "perosis", or what is popularly known as "slipped tendon"

In normal circumstances the poultry man need concern

himself only with calcium, sodium, phosphorus, chlorine, and possibly manganese and these are readily provided. Oyster-shell, cockle-shell or limestone grit will supply calcium; steamed bone flour or bone meal will provide phosphorus; while common salt will provide sodium and chlorine.

When calculating the phosphorus content of the diet it is necessary to distinguish between total and available phosphorus, because much of the phosphorus in cereals is in the organic form of Phytin, little being assimilated by poultry.

The amount of available phosphorus should be based on that present in fish meal and other animal products, *e.g.*, bone meal, and/or that present in inorganic form in dicalcium phosphate or defluorinated phosphate, together with about 30 per cent of the phosphorus present in other ingredients of the diet.

The majority of rock phosphates and certain other sources are unsuitable for poultry feeding, either because the phosphorus is not available and/or because they contain a high percentage of fluorine.

There is rarely a deficiency of manganese in poultry diets, but a deficiency may arise from the inclusion of a high percentage of steamed bone meal, meat and bone meal, dried yeast or fish meal which could cause mineral imbalance, particularly through a high phosphorus intake. It may also arise in diets consisting largely of cereals, all being relatively deficient in this element compared with the mill offals bran and middlings.

The manganese requirements will be fully satisfied by the addition of commercial anhydrous manganese sulphate to the diet at the rate of 4 oz. per ton of food.

To ensure uniform distribution, 4 oz. of manganese sulphate may be mixed with 10 lb. of common salt, the mixture being added to the mash at the rate of one half of 1 per cent.

Manganese is essential for high hatchability. A severe deficiency will result in dead embryos of small size with parrot-like beaks, shortened limbs and wiry down. These effects are aggravated by an excess of calcium and phosphorus. They are not, however, specific symptoms of manganese deficiency.

Experimental work has demonstrated that, given a ration of average composition—containing cereals and offals, and a protein concentrate such as milk, meat-and-bone or fish meal

in adequate proportion—the birds will have all the minerals they need with the exception of calcium and common salt, and even the latter is unnecessary if the mash contains 10 per cent fish meal, although it may be included.

Vitamins. Vitamins are accessory food factors. The study of vitamins dates from comparatively recent times, and although great progress has been made by scientific research, new facts are constantly being brought to light and new vitamins discovered.

Vitamins are of practical importance, particularly where intensive methods are practised.

Where birds are kept in confinement, or in runs where grass is not available, vitamin deficiency may be responsible for arrested growth, susceptibility to disease, infertility, rickets, paralysis and other nutritional diseases.

An outstanding characteristic of vitamins is that they are required only in minute quantities. Thus Hopkins, quoted by Halnan, found that rats ceased to grow when their diet consisted of casein, fat, starch and plant ash (obtained from oats), although the food was digested. When, however, two or three drops of fresh milk were given daily they recovered, growth was resumed and they reproduced normally when adult.

As the chemical composition of vitamins was unknown at the time of their discovery, they were referred to by letter. Further research has shown that some of the vitamins are not in fact single vitamins, but include several vitamins, each having specific properties. Thus, at one time vitamin B was thought to be one vitamin, but it is now known to contain several factors designated vitamin B_1, B_2, and so on.

With the advance in knowledge of vitamins, nomenclature has been applied to them, and many are now commonly known by name not by symbol. Among exceptions are vitamin A, C, E and D_3, which the poultryman prefers to use rather than long scientific names.

Moreover, the chemical composition of many vitamins is now known and they are produced synthetically on a commercial scale.

Vitamin A. This ranks in importance with vitamin D_3 in poultry-feeding, for the reason that under certain conditions commonly found in practice there may be a deficiency in the diet

A deficiency of vitamin A will cause arrested growth weakness, diarrhoea and susceptibility to disease Because of its effect on growth it was at one time known as the growth promoting vitamin This description was misleading because a deficiency of other vitamins will have the same effect It is now called the "protective vitamin" because it increases resistance against infectious diseases

Lack of vitamin A in the diet of fowls is responsible for a condition termed "nutritional roup" Birds affected with this disease become debilitated, lose flesh and show paleness of comb There is a whitish discharge from nostrils and eyes, the latter becoming swollen sometimes to an enormous size A characteristic feature of the disease is the presence of small whitish pustules in the oesophagus

Good sources of this vitamin are cod, halibut and certain other fish liver oils For practical purposes grass, clover, alfalfa, yellow maize, carrots, kale, spinach and other green vegetables are also good sources Although the vitamin does not occur in green plants or vegetables these do contain pro-vitamin A substances (carotenoids), which are converted into vitamin A in the bird's body Synthetic vitamin A is available

Estimates of vitamin A requirements (1,200 I U per lb for chicks 2,000 I U for adult birds) are based on experiments using feeding oils and alfalfa meal as sources of this vitamin and provide for some unavoidable loss during storage of the foods

Recent work at Cornell University using stabilized dry vitamin A, in which the vitamin is readily available has shown that minimum requirements for this vitamin are lower than the above estimates and are approximately 300 600 I U per lb for chicks 1,200 1,600 per lb for hens

It is suggested therefore that when sources of stabilized vitamin A are used lower levels than previously specified will be adequate

Vitamin B This is known as the vitamin B complex because research has shown that it comprises a large number of chemically and physiologically distinct vitamins and it seems probable that others will be isolated

At present about a dozen components have been isolated and synthetic forms prepared

The requirements of poultry for any particular member of this group vary considerably, although, of course, in comparison with the need for other vitamins, they are small but nevertheless essential

A diet containing a number of feeding stuffs of [illegible] origin, such as that normally fed on the poultry farm, [illegible] furnish most, if not all, the vitamins of this class, and where the birds are able to supplement their [illegible] quality, the possibility of a deficiency of any of these vitamins is remote If, however, intensive methods are practised [illegible]

the range is of poor quality, then there may be a deficiency of some of the factors classified under the heading of the vitamin B complex

Salient features of vitamins of this group likely to be of interest to the poultryman are as follows —

Vitamin B1 (Aneurin or Thiamin) —A ration deficient in vitamin B1 results in arrested growth and certain nervous disorders, including paralysis of the leg, and wing nerves (polyneuritis) Vitamin B1 is abundantly supplied in the average ration Cereals, bran, middlings and grass are good sources, hence there is no danger of a deficiency arising when a normal ration is fed

Vitamin B2 —This is now more commonly referred to as riboflavin (vitamin G) A deficiency retards the growth of chicks and causes a condition known as "curled toe paralysis"

A deficiency in the diet of breeding-stock will lower hatchability, and embryos that fail to hatch may show a condition known as "clubbed down", when the end of the down is bulbous, due to the failure of the down to rupture the sheath

Riboflavin is present in green vegetables, grass, alfalfa, yeast, milk, liver and meat meal Relatively cheap riboflavin supplements produced by a fermentation process are now available

The chief danger of a deficiency of this vitamin arises when the breeders' mash is mixed on the farm without due regard to the nutritional needs of this class of stock, or when properly compounded breeders' mashes intended for all mash feeding are used with grain which of course has the effect of diluting the mash

In an all mash ration containing 5 per cent of grass meal, the addition of 3 per cent of unextracted yeast or 5 per cent of dried whey or skimmed milk, will meet the birds' requirements for this vitamin If grain is fed, the amount should be doubled in the mash part

Vitamin B6 (pyridoxine) is present in grass, yeast, milk, liver, fish and meat meals, and wheat A deficiency results in retarded growth, general weakness and nervousness

Pantothenic Acid (The Filtrate Factor) —This is of interest because a deficiency causes poor growth and feather development, poor egg production and hatchability It also results in dermatitis—sores on feet and in corners of mouth and eyes It is present in many common feed stuffs, such as bran, alfalfa, grass, yeast, milk, cereal grains, molasses

Biotin (vitamin H) —Deficiency causes dermatitis (first appearing on feet), perosis, poor hatchability It is present in yeast, liver, milk, wheat, molasses and green food

Nicotinic Acid (Niacin) —A deficiency of this factor will cause inflammation of mouth in young chicks, white tip on tongue, perosis, poor growth and feather development It is present in yeast, wheat, bran, liver and milk

Vitamin E—At one time this was known as the anti sterility vitamin This is a misnomer, because male birds fed a deficient ration are capable of giving high fertility A deficiency will, however, cause low hatchability

Lippincott refers to experiments, carried out at the Illinois Agricultural Experimental Station, showing that eggs laid by hens having a ration deficient in vitamin E failed to hatch, but the addition of 0 5 c c of wheat germ oil per bird per day brought about an immediate improvement

Vitamin E is widely distributed in common feeding stuffs, and it is unlikely that any practical diets are inherently deficient When deficiency occurs in the field it is usually due to interfering substances present in the diet—*e g*, rancid oil—destroying or inactivating the E vitamin or preventing its absorption or utilization

This vitamin is essential for normal growth Chicks having a deficient diet show inco ordination of movement and symptoms of "fits" The condition is known as crazy chick disease

Vitamin K—This is the antihæmorrhagic vitamin If it is deficient in the diet, hæmorrhages occur on the breast, legs and other parts of the body, accompanied by delayed clotting of the blood The average ration will not be deficient in this vitamin, as it is present in cereal grains, kale, alfalfa, fish products and other commonly used foods It is a fat soluble vitamin

Deficiency of this vitamin is believed to be partially responsible for so called hæmorrhagic disease, and there is evidence that requirements are increased by certain drugs, particularly those of the "sulpha" group Outbreaks of this disease have occurred in certain circumstances following the introduction of these drugs for the treatment of coccidiosis

When sulpha drugs are fed it may be advisable to increase the proportion of foods rich in vitamin K such as grass meal or fish products

This does not complete the list of vitamins, but others are of little practical importance In fact, the poultry-man using a normal ration need not concern himself with vitamins, with the exception of vitamins A, B2 (riboflavin) and, if the birds are closely confined, vitamin D

The Animal Protein Factor The isolation of vitamin B12, and subsequent research into the problems associated with unidentified growth factors usually present in protein rich foods from animal sources, have led to an entirely new conception of the composition of poultry diets in regard to their protein content

Prior to recent discoveries it was assumed that the improved growth rate following the addition of animal protein to vegetable protein diets was entirely due to the difference in the amino-acid constitution of the two classes of protein. Research has shown, however, that this is not the only limiting factor, and that by the addition of small amounts of the animal protein factors to vegetable protein diets which are quantitively and qualitatively complete in amino-acids, it is possible to ensure normal growth.

This means in effect that the poultry-man is no longer completely dependent on animal protein concentrates, and, in view of the high cost of these foods, the significance of the discovery will be recognized.

So great is the importance of recent research in this field of poultry nutrition, that brief reference should be made to it.

In 1942 Hammond, in experiments at the Bureau of Animal Industry, Beltsville, U.S.A., found that the addition of small quantities of cow manure or a water extract of the manure, when mixed with a low-grade diet, resulted in increased rate of growth in chicks.

Bird and his associates later found that the chick-growth factor present in cow manure was also present in the droppings of hens, even when the diet of the latter did not contain it. The factor is synthesized by micro-organisms present in the digestive tract of the bird, but owing to the rapid passage of the food, no appreciable quantity is elaborated until after the droppings are voided. The droppings of growing chicks (three to six weeks old) did not contain measurable amounts of the growth factor.

Bird and his colleagues, by using a diet consisting of yellow maize meal, barley meal, alfalfa meal and soya-bean meal supplemented with all hitherto known growth factors, found that cow manure furnished an unidentified factor essential for maximum growth.

In selecting chicks for this work great care was necessary to ensure that they were obtained from hens showing low hatchability, because it was known that variation in hatchability could be avoided if the hens had access to cow manure. Furthermore, it was also shown that chicks given a deficient diet grew better if the breeding-stock had received the hatch-

ability factor This demonstrated that the cow-manure factor was transmitted in the egg

Later work showed that the protein present in the water-extract of cow-manure was not an integral part of the unknown factor—that is to say, the latter is not a protein

Subsequently Bird suggested that protein supplements fall into three main groups, namely —

(1) A group that includes fish meal, in which the protein contains sufficient of the unknown growth factor to enable the birds to make full use of the protein in the diet for growth and hatchability

(2) A group including soya-bean meal, in which the proteins give their full effect only when the diet is supplemented with the unknown factor

(3) A group including maize gluten and cotton seed meal, that requires other factors in addition to the unknown growth factor to enable the birds to make full use of the protein in the diet

Bird and his associates also found that fish meal was a better source of the unknown factor than meat meal in the early stages of growth, but later meat meal was equally effective, and that the need for the unknown factor was greater in the early stages of growth than later At first it was considered that the crystalline substance obtained from liver extracts, known as vitamin B12, was identical with the animal protein factor, but it is now known that vitamin B12 is only a part of this factor

To provide adequate amounts of the animal protein factor (A P F), from 3 to 5 per cent of liver meal or fish meal should be included in the diet These foods are superior to meat meal for this purpose

Recently, the watery solution (so called "stick water'), obtained as a by-product in the manufacture of fish meal, has been shown to be an excellent source of A P F This solution, when concentrated by evaporation, is sold commercially as Condensed Fish Solubles, and has given results equal to those obtained with fish meal when added to vegetable protein diets

Cow manure, in addition to containing variable quantities of the animal protein factor, also contains an androgenic (male

hormone) substance, and if fresh manure is included in the diet it may lower egg production. It will, however, improve hatchability when vegetable protein diets are fed.

Palafox and Rosenberg (1951) (University of Hawaii) found that oven- and air-dried cow manure satisfactorily supported egg production, egg-weight, body-weight, hatchability and feed consumption when fed at 5 and 10 per cent levels in an all-mash ration.

Air-dried cow manure fed at 15 per cent, when supplemented with herring meal, was satisfactory for egg production, egg-weight, hatchability and feed consumption, but not body-weight.

Fifteen per cent oven-dried cow manure not supplemented with herring meal depressed egg production, but did not significantly affect body-weight.

Antibiotics. Following the isolation of vitamin B12, it was found that by-products from the manufacture of antibiotics contained considerable quantities of the vitamin. These products are the residues of fermentation in the commercial production of aureomycin, streptomycin, bacitracin, penicillin, terramycin and so on.

It was subsequently found that when these products were included in the chick diet there was a greater stimulation of growth than was achieved by the addition of vitamin B12 only. The reason for the higher rate of growth even when antibiotics are included in balanced diets is not fully understood, but it is believed that they result in the destruction or inhibition of harmful organisms in the digestive tract.

Many of these organisms not only deprive the birds of some of the nutriment in the feeding-stuffs but also produce toxins which when absorbed cause loss of appetite in greater or lesser degree. Thus antibiotics stimulate the appetite.

They may also encourage those intestinal micro-organisms which synthesize vitamins. There is no evidence that antibiotics synthesize vitamins *per se*.

It has been shown that when chicks are reared in new houses and equipment or in houses and equipment that have been thoroughly cleaned, disinfected and left unoccupied for a short time—two to three weeks—antibiotics are less likely to induce growth response

With antibiotic supplementation Carpenter (1952) reported a weight gain of 11 per cent and improved feed conversion efficiency of 4 per cent, compared with a control group of chicks up to twelve weeks of age.

The effect of these supplements is most marked during early life. Under adverse conditions it may be spectacular. They do not increase adult body weight or induce early sexual maturity.

Antibiotics are not recommended in routine feeding of chicks reared for laying stock replacements. The producer should be satisfied that the additional cost of feeding antibiotics is warranted under his conditions.

Antibiotics assist in countering the effect of low infection that builds up in houses and appliances in continuous use, infection that while not necessarily causing mortality results in morbidity, i.e., slower growth, and generally less efficient production.

They are very useful as a tonic following outbreaks of disease, e.g., coccidiosis, and in the actual treatment of certain diseases, e.g., blue comb or pullet disease. They are also useful in countering the effect of many stress factors that retard growth and cause a slump in egg production.

There is no evidence that antibiotic feeding during the growing period will result in improved production in the laying house.

Many experiments have shown that antibiotics will promote egg production when it is low as the result of subclinical infection.

When antibiotics are fed to flocks in which the rate of egg production is high there is no improvement or insufficient improvement to warrant the additional cost of antibiotics. On the contrary, when egg production is low due to low grade infection or other adverse condition the use of antibiotics may improve production markedly, in certain circumstances spectacularly. But feeding antibiotics to adult birds is not generally recommended. The Agricultural Research Council cannot at present advise the wider use of antibiotics in animal feeding.

Antibiotics are now commonly included in diets used for table poultry production. Most compounders supply table

poultry mashes or crumbs with antibiotics, and the latter are also available as a pre-mix for adding to mashes on the farm.

For table-poultry production antibiotics are usually included in the diet at rate of 5–25 grams per ton. This is known as low-level feeding. But high-level feeding (50–100 grams per ton) is practised for restricted periods following disease or stress. High-level feeding is recommended when table chicks tend to lose their appetites, which may occur as killing time approaches.

High-level feeding should not be continued for more than ten days; it should be followed by feeding at half the amount for seven to ten days.

Antibiotics may be given in the drinking-water, but this is a *wasteful practice.*

Unidentified Factors. In addition to all known amino acids, vitamins and other nutrients, there are some factors essential for growth and reproduction that have not yet been identified. They are present in products, such as fish meal, meat meal, yeast, milk, whey, grass juice and fermentation solubles.

Unidentified factors are present in diets of normal composition, for they include some of the above feeding-stuffs.

Other Growth Promoters. Some experimental work has shown that certain arsonic acid compounds and by-products in the manufacture of detergents have growth-promoting properties, but in other experiments these supplements have proved ineffective. Probably response depends on environmental and other factors. At present there seems little justification for their inclusion in poultry diets. By-products of synthetic detergents are known as "surfactants" —surface-acting agents.

Chapter Sixteen

The Nutritional Requirements of Poultry

The Balanced Ration. This may be defined as a ration capable of satisfying the nutritional requirements of the birds without waste, the several nutrients being present in the correct proportion for the purpose for which the birds are being fed.

In practice this ideal cannot be achieved because individuals differ in their needs and in the efficiency with which they utilize their food

Therefore, in order to meet the requirements of all the birds in the flock, the ration must be so compounded that it will provide a margin of safety sufficient to ensure that every individual will receive all it requires, that no bird shall be underfed

The scientist in his investigations works within narrow limits He endeavours to discover actual requirements, and in doing so he has presented the practical man with data that enable him to make up more economic and efficient rations and to avoid many of the serious errors in feeding that were committed before scientific knowledge was so far advanced

Finality has not been reached by any means, indeed, the scientists are the first to point out that our knowledge of poultry nutrition is far from complete, but very great progress has been made during the past twenty-five years, and the work still goes on

In making up the ration the requirements for the following purposes must be considered —

(1) Maintenance
(2) Growth
(3) Table Egg *Production*
(4) Hatching
(5) Fattening

Maintenance. A maintenance ration is one that "keeps

position. Experimental work is concerned with the mineral requirements for growth and production

Information regarding the vitamin requirements for maintenance is also meagre, the work at experimental stations being devoted largely to investigation for growth and production purposes

Growth. *Protein and Mineral Requirements* Many experiments have been carried out at numerous centres in this country and overseas to determine the nutritional requirements of chicks

At the outset it is perhaps advisable to emphasize that the chick is an extremely rapid-growing creature, and hence its requirements are considerable, especially during the early stages

The weight of a day-old chick is about 1 4 oz Given a well-balanced ration a pullet chick will double its weight in about ten days, at a month old it will weigh about six times its weight when hatched, at six weeks about twelve times, and at eight weeks about eighteen times Cockerels grow even more rapidly

A point of interest is that the amount of food required to produce 1 lb of live-weight gain shows a progressive increase, the first pound being most economically produced as far as food consumption is concerned The law of diminishing returns applies because the larger the chick the greater proportion of the food consumed is required for maintenance

In a paper read at the Fourth World's Poultry Congress (1930), Titus and Hendricks pointed out that rate of growth was a matter of food consumption rather than of time In other words, given the normal diet, the weight of the chick could be more accurately determined by the amount of food consumed than by its age

The nature of the food requirements is most accurately assessed by noting changes that occur in the composition of the body

At the Cambridge School of Agriculture, Halnan adopted the plan of analysing the bodies of the chicks at different stages of growth and keeping records of food consumption

He presents the following table in the Scientific Principles of Poultry Feeding (*Bulletin No 7, Ministry of Agriculture*) —

so fed will attain greater size, mature more slowly and lay larger eggs It is true that low-protein feeding will retard growth in the early stages, but unless there is an actual deficiency, chicks on low-protein diets grow faster than those on high-protein during the later stages, so that ultimately they attain about the same body-weight

Heuser and Norris (1930) fed two groups of pullets on rations containing about 11 and 28 per cent of milk respectively The high-protein group grew more rapidly than the low-protein group up to about twelve weeks of age, when the low-protein group grew more rapidly At thirty three weeks of age the average weight of the two groups showed little difference

Body-weight and size of egg are inherited characters They are not dependent on the percentage of protein in the ration, unless the latter is so unbalanced that there is protein deficiency

The total protein of the diet should be about 18 per cent for the first eight weeks for chicks reared for laying (see p 330)

When feeding table chickens it is common practice to replace a chick diet with a growers' diet from eight weeks of age to marketing The growers' diet usually contains about 15 per cent protein, and is fed as an all mash or pellet ration Alternatively, chick mash may be fed throughout, grain being introduced from about seven or eight weeks of age

In broiler production higher protein diets are usually employed, a starter chick diet containing about 21–23 per cent protein for the first six to seven weeks, when the protein content is reduced to about 17–18 per cent, by replacing the starter mash with a growers' mash Many producers feed a table chick diet in mash, crumb or pellet form from day old to marketing

Energy Requirements The energy requirements for growth is not a matter of major concern to the pullet rearer, because a diet of average quality will furnish sufficient energy for growing pullets

If, however, the fibre content is high it may fail to do so, resulting in arrested growth and perhaps mortality

During the last war heavy losses were experienced among chicks on some farms The trouble was popularly known as "six day disease" because most of the losses occurred in chicks

The optimum calcium–phosphorus ration varies with the diet, but for practical purposes it may be assumed to be 1 6 1 The majority of chick and growers' mashes and pellets contain adequate mineral matter, and need not therefore be supplemented

Vitamin Requirements Given a normal ration consisting of the usual meals and offals and protein concentrates, there are but two vitamins likely to be deficient They are vitamins A and D_3 These are furnished in adequate amounts by the inclusion of 1 per cent of a good sample of cod-liver oil in the mash, or the appropriate amount of synthetic vitamins Vitamin A may also be provided by feeding 5 or 6 per cent of a high-grade sample of dried grass or alfalfa meal, while the chicks will synthesize vitamin D if exposed to sunshine

Instances of riboflavin deficiency are occasionally reported As already mentioned, yeast, milk, liver-meal, meat meal, fresh and dried grass are good sources of this vitamin It is also available in synthetic form

Requirements for Egg Production In the course of twelve months birds of a laying strain will produce many times their own weight of eggs

A pullet weighing about 5 lb and laying 180 2 oz eggs in her first season will have produced 22½ lb of eggs, or four and a half times her weight

It is clear, therefore, that a considerable proportion of the food consumed will be required for egg production, nevertheless, the greater part is needed for maintenance Thus it follows that the more eggs a bird lays the more economically they are produced, since the amount of food required for the maintenance of birds of equal body-weight is more or less constant

This statement must be qualified, however, for some birds utilize the food more efficiently than others

Table 35 shows the average amount of food consumed by birds of different weight for different levels of egg production The estimates are necessarily approximate, because actual consumption is influenced by the composition of the diet and the quality of its ingredients

This information is given merely to show that good layers use the food more efficiently than poor producers It also shows that given an equal number and weight of eggs, the

At current relative prices of cereals and offals, however, wheat, maize and barley are cheaper sources of energy than bran and middlings.

Ground cereals are therefore widely used in mashes, but since they are of lower protein content than offals, a proportionate increase in the amount of protein-rich foods must be included to maintain the optimum level of total protein in the diet.

Similarly, soya-bean meal is a cheaper source of protein than fish meal, despite the higher protein content of the latter. Consequently, if soya-bean meal is relied upon to furnish the bulk of the protein-rich foods appropriate adjustments should be made to ensure the correct proportion of total protein in the diet.

On range of good quality the amount of protein concentrates can be reduced by 50 per cent during spring and summer if the grass is growing freely and is kept short. Under very favourable conditions, where natural foods—young grass, grubs, earth worms and insects—are plentiful, no protein concentrates are needed for growing or laying stock.

When little or no protein concentrates are fed range conditions must be studied. Should the grass be in short supply due to a spell of hot weather or over-stocking, or should it be left to grow rank, then the normal percentage of protein concentrates should be included in the diet.

During the winter period it should be assumed that no natural food is available; the birds should have a completely balanced ration.

The quality of the protein concentrate must be considered when compounding diets, and a distinction should be made between vegetable and animal proteins.

A great many trials with protein foods have been carried out.

Between the chick feathers and adult plumage there are one or two further sets of adolescent feathers, although usually only one set, the change taking place at about thirteen to fourteen weeks old. It will be understood that the growth of the feathers is continuous, the early feathers are not shed until they are fully grown, when others gradually replace them.

The final adolescent (growers') feathers are retained until just before maturity is reached, when they are replaced by the adult plumage. Growth of the latter, however, is not complete when birds of prolific strains start laying.

In normal circumstances the adult plumage is not changed until the end of the first laying season, when the annual moult takes place.

Thus it will be seen that both the growing chick and the adult require considerable protein for feather-growth.

Is special feeding necessary during the moult? The question is perhaps answered most satisfactorily in the following terms. If the birds finish the season in good condition, a ration that has proved suitable for laying is equally suitable for moulting. Should the birds be in poor condition, then they should be liberally fed, the ration containing rather more protein than is usually recommended for layers. Dried skimmed milk, meat and bone and fish meals are the most suitable protein concentrates.

The sulphur content of feathers is comparatively high, and because of this the addition of flowers of sulphur to the mash is occasionally recommended. There appears to be no evidence that it is of value. Sulphur should be provided in the organic form in which it is present in the protein foods already mentioned.

Hatching-egg Production. Numerous experiments have demonstrated that rations that will keep the stock in good condition and enable a high level of egg production to be maintained are not necessarily equally satisfactory for the

The inclusion of soya-bean meal, ground-nut meal, peas or bean meal in breeders' rations will not lower hatchability provided they are supplemented with animal protein of good quality

In work at the University of Reading, Black and his associates found that the addition of white fish meal at the rate of 6 per cent and 11 per cent in all cereal diets depressed hatchability Although the meal lowered the vitamin A content of the diet, there was an ample margin of safety in this respect Only certain samples of fish meal have this effect, but in view of the work of Black and other investigators, it is advisable to exercise care when including this food in breeders' diets

Mineral Requirements for Hatchability The mineral requirements of breeding-stock appear to be similar to those of laying stock

In normal circumstances a ration of average composition will provide the essential mineral matter with the exception of calcium and possibly manganese Hence the importance of supplying oyster-shell, limestone grit or other supplement having a high calcium content

The shell of the egg is a source of calcium for the developing embryo, it also affects the rate of gaseous exchange—that is to say, the absorption of oxygen and the expulsion of carbon dioxide during incubation Thin-shelled eggs are therefore unsuitable for hatching purposes Chicks hatched from them will be weakly

A deficiency of manganese has an adverse effect on hatchability and produces susceptibility to perosis in chicks, but it is unlikely that a deficiency will occur, because the average ration is well off in this respect Moreover, breeding stock are usually kept on grass range—an excellent source of this and other minerals known to be required only in small quantities

If there is reason to believe manganese may be deficient, commercial anhydrous manganese sulphate should be included in the mash Owing to the small quantity required (4 oz per

hatching eggs are required

Stock on range should also have a complete breeders ration at all times Even in the spring when the grass is growing freely the breeder is not justified in feeding a layers' ration

Requirements for Fattening. Birds intended for table should receive a good standard chick ration until they are eight weeks old Thereafter a well-balanced growers' mash or growers' pellets should replace the chick mash Some producers feed growers' mash supplemented with pellets or wet mash fed once or twice a day

This refers to feeding for the production of large table chickens For smaller (broiler) chickens marketed at about 10 weeks old high energy diets are employed

For fattening proper—that is to say, trough feeding and cramming—obviously a diet rich in carbohydrates and comparatively rich in fat should be fed, but as the birds are not mature when put in the crates it is necessary to provide also for further growth For this purpose there is nothing to equal skimmed milk

For years it was customary to use dried skimmed milk at the rate of 1 lb per gallon of water, which gives a mixture of approximately the same composition as fresh skimmed milk Experiments at the Southern Section of the National Poultry Institute at Wye, Kent, have shown that the percentage of milk can be reduced by half without affecting the rate of fattening Experiments at this centre have also shown that the inclusion of mutton-fat in the cramming mixture is fully justified

Oats While there is prejudice against barley, the value of oats is often exaggerated Experimental work has failed to confirm the popular belief that the oat is the finest grain for poultry For laying stock it does not compare favourably with yellow maize Samples vary enormously in quality, and many of the inferior samples are almost valueless, consisting principally of husk Only plump white oats should be purchased They should be "clipped" to remove the awns and fibrous tip of the grain A good sample will weigh not less than 40 lb per bushel

The grain contains about 10 per cent fibre, and although it is of a type that can be fed in large amounts without detriment to the health of the stock, a high proportion will lower the efficiency of the diet Oats are especially useful in feeding breeding stock and growing pullets

Black oats of comparable quality have the same nutritional value as white varieties, and are fed on many farms Until the birds are accustomed to them, however, they tend to leave them in the litter They should be trough fed at the outset

Yellow Maize This is a most valuable grain for poultry, especially for laying stock It is palatable and highly digestible It is a rich source of carbohydrates, and for this reason it is of the greatest assistance in maintaining the body weight of birds when they are laying rapidly It is a fair source of vitamin A, or more correctly, the pro vitamin A substance, and it imparts a desirable colour to the yolk It should be fed liberally to layers, particularly during the winter months when, if there is a tendency for the birds to lose weight, the whole of the grain ration may consist of it

Its protein is of poor quality, but that need cause no concern because there are other sources of this constituent of the diet

White maize is deficient in vitamin A and should be used only for the final fattening stages in table poultry production, and then in meal form

For young chicks, however, it would appear that when ground sorghum is used to replace 30 per cent maize meal in an all-mash diet, it tends slightly to depress food consumption and growth rate.

(2) *Adult Birds.* For adult birds on grass range, sorghum successfully replaced half of each of the other grains in a mixture consisting of 40 per cent maize, 40 per cent dredge corn (oats and barley) and 20 per cent wheat.

For battery laying birds, ground sorghum used at the rate of 40 per cent proved a satisfactory substitute for 20 per cent maize meal and 20 per cent ground wheat in a typical laying battery mash.

Millet. Millet has about the same composition and value as wheat, but unless it is attractive on comparative price it is not worth using. As the grain is small it is suitable for use in chick grain-feeds.

Samples of millet meal are occasionally offered. If of good quality they are suitable for inclusion in diets for all classes of stock.

Soaked and Sprouted Grain. Some years ago sprouted grain (usually oats) was frequently used. When grown in the light it was regarded as a substitute for greenstuff.

There does not appear to be any advantage in sprouting the grain; soaking in water for twenty-four hours seems to be equally beneficial so far as palatability is concerned. Feeding trials do not confirm that soaked (or sprouted) grain improves egg production, but there is no doubt that it is very palatable. Birds in confinement or on range in hot weather will eat it readily when appetites for dry grain are flagging.

Soaked grain should be fed in troughs.

Fry *et al.* (1957) found that water treated ground barley markedly improved its nutritional value for chicks. Treated barley was almost equal to maize, both with regard to growth rate and food-conversion efficiency.

Studies by Willingham, Jensen and McGinnis (1959) showed

A good sample should be soft to the touch and leave flour on the hands when passed through them. Middlings should contain much of the wheat germ.

Weatings. Middlings, also known locally by such names as sharps, parings, thirds, toppings, differ so widely in quality that in 1933 The Millers Mutual Association introduced a scheme to standardize the quality of home-milled middlings and arranged for its marketing under the trade name "Weatings".

The scheme was an outstanding success, but it was abandoned during the War, and for some years after it because it was impossible to market a product of the required standard.

Re-introduced in 1958, Weatings is again the name given to home-milled wheatfeed of guaranteed quality.

"Weatings" is a trade mark. There are two grades (*a*) Weatings with a fibre content of 6 per cent; (*b*) Superfine Weatings with a fibre content of 4·5 per cent.

Ground Oats. In common with that of whole oats, the value of ground oats has been over-rated in many quarters. There is no special virtue in this foodstuff compared with other cereal meals, and the extent of its inclusion in the ration should depend on prevailing prices of similar foods, such as middlings, barley meal and maize meal.

So-called Sussex ground oats, the favourite food of the Sussex fattener, are stone-ground, but a sample of comparable quality produced by steel-mills is equally satisfactory. So efficient are some of the modern steel-mills that they will grind husks so fine that the practical man is unable to detect adulteration. Some samples of ground oats readily purchased by the poultry-man are prepared from inferior grain that he would not buy.

Ground oats should be a creamy colour. White samples indicate adulteration with barley meal or, possibly, tapioca root.

Stone-ground oats feel soft, whereas steel-ground samples are a little gritty. A good test of quality is to heap up a small sample on a table by pressing with fingers and thumb. A good sample will remain in a small pile, while inferior samples break down owing to their coarser texture.

Oatfeed or Feed Oatmeal. This is a by-product obtained in the processing of oats for human consumption. It is the offal of the

content. Most samples of the gluten meal are superior to the gluten feed for poultry-feeding purposes.

Barley Meal. Barley meal is a very satisfactory food, especially useful for fattening. Tests with laying-stock show that it has about the same value as ground oats. If desired, it may be fed up to 30 or 40 per cent of the layers' or breeders' ration. It may also be used for growing stock. For trough-feeding and cramming 60 per cent by weight of the dry mash may consist of it.

Wheat meal—ground whole wheat—may constitute up to 80 per cent of the diet. It is suitable for all classes of stock. It should be roughly broken, kibbled or rolled. It should not be finely ground, for if reduced to a fine meal it will cause digestive trouble.

Alfalfa Meal and Grass Meal. These meals have similar properties. They consist of the dried plant ground to a meal. Their value depends on the stage at which the crop is cut; the younger the growth the more nutritious the meal. If the crop is cut late it becomes harder and more fibrous, especially after seeding.

The chief value of these foodstuffs lies in their mineral, xanthophyll and vitamin content, particularly their provision of carotene and riboflavin.

Grass meal has become a popular food in recent years, a number of drying-plants having been erected in this country. A sample of average quality will contain 16–18 per cent protein and 200–250 milligrams of carotene per kilogram. The fibre content is about 18–20 per cent and the meal is not very palatable. For these reasons it is inadvisable to include more than 10 per cent in the diet for growing and adult stock, 5 per cent for chicks. *The meal should not be regarded as a* satisfactory source of protein for poultry because much of the protein is locked up in the fibre and is therefore not available to the birds.

Biscuit Meal. This is a carbohydrate food of high nutritional value, but in recent years its cost has been prohibitive. When available at an economic price it is very suitable for inclusion in bulky mashes having a high fibre content, owing to its high digestibility and lack of fibre. It thus assists in balancing the ration.

There are two kinds of biscuit meal. One consists of the waste from biscuit factories and usually contains a rather high percentage of sugar. The other is made from low-grade flour and is a by-product of dog-biscuit manufacture. This kind is commonly reinforced with animal protein, and is more valuable than the former. It may be used as a substitute for ground oats and maize meal.

Brewers' Grains. About 15 per cent of this foodstuff may be included in growers' and layers' rations. It is unsuitable for chicks. The fibre content is high (about 15 per cent) and the food bulky.

therefore when feeding them care should be taken to ensure that the ration is balanced by the inclusion of protein concentrates, common salt and, unless the birds are on range of good quality, vitamin concentrates or vitamin rich foods to maintain a balanced diet

Potatoes should be washed to remove surplus soil and boiled in their skins Boiling is necessary to ensure digestibility of the starch granules When raw potatoes are fed, the droppings are heavily charged with starch granules, thus showing that they are not digested For chicks potatoes should be peeled

Potatoes cannot be appraised merely by comparing current market prices with those of meals Allowance must be made for the high moisture content, the cost of cooking and the additional labour entailed in wet mash feeding

Artichokes May be used to replace a proportion of the carbohydrate foods The carbohydrate is not starch but inulin, and there is some doubt about the value of this substance However, during storage this is converted into sugar (fructose) For this reason artichokes should not be used before February

Fodder Beet In recent times the use of fodder beet for feeding farm stock has received much publicity It is fed extensively in European countries, particularly by Danish pig feeders

The writer is not aware of experiments to test the value of this foodstuff for poultry, although on a number of farms it has been used for fowls

There are several varieties of fodder beet, but for practical purposes they may be regarded as one Fodder beet contains about 22 per cent dry matter, 8 5 per cent protein, and since the carbohydrates are present largely in the form of sugar, *unlike the potato it need not be boiled*

It is a heavy cropper, yielding about 20 tons per acre

It may be finely minced and mixed with wet mashes or the roots may be cut in half when the birds will peck out the fleshy part Up to 2 oz per head per day may be fed an amount which would replace about 4 oz of dry meal

Sugar beet Pulp This by product obtained in sugar production has a rather high fibre content, and it is not a palatable foodstuff for poultry A trial carried out by the writer some years ago proved unsatisfactory In an emergency it may be

fed at the rate of 5-6 per cent in a dry mash or 10 per cent in a wet mash for growing and adult stock. It must not be given to chicks.

Sugar-beet pulp is more suitable for the larger farm animals than poultry.

Roots. With the exception of carrots, other roots such as mangels, swedes and turnips are of low nutritional value, and the poultry-man would not be justified in growing these crops especially for poultry.

In the absence of fresh green food, roots will provide occupation for the birds and thus assist in preventing vices among confined stock.

Tapioca Meal. This material is occasionally available for poultry feeding purposes. It is a concentrated meal containing about 81·1 per cent carbohydrates, little fibre (2·5 per cent) and protein (1·8 per cent).

It may be used as a substitute or partial substitute for cereal meals and may constitute some 35-40 per cent of the mash, but 20 per cent is a fair level in normal circumstances. Owing to its concentrated nature it should be used with feeds having reasonable bulk to provide a mash of suitable texture.

Seaweed Meal. Samples of this meal are extremely variable in quality and composition. Some contain a high percentage of mineral matter. Good samples contain about 10-11 per cent protein, 8·0 per cent fibre and 16-18 per cent ash.

They may be included in the mash at the rate of from 5 to

the war It consists of waste collected from households, hotels and restaurants The material is steam cooked and then turned into moulds to cool, when it has the consistency of stiff pudding It is popularly known as "pudding" by poultry keepers

Pudding is a coarse, bulky foodstuff, not ideal by any means, but useful when other and more suitable foods are not available The composition of this material is variable, depending to a great extent on the season An average sample contains about 32 per cent dry matter and about 13 per cent protein on a dry weight basis On this basis also 8 oz will replace about 3 oz of mash

Controlled experiments and the experience of practical men during the war years have assessed the value of pudding Satisfactory egg production is obtained from birds receiving 2 oz of mash with 8–10 oz of "pudding" per head per day It is not necessary to supplement this foodstuff with proteins, for in this respect it constitutes a fairly well balanced food

With more nutritious foodstuffs freely available, however, "pudding" cannot be recommended In terms of food conversion it is not an efficient food Maximum rate of growth and the high egg production of modern laying strains demand diets of higher energy content than can be produced when pudding is included in the mash

Pulverized Waste This consists of pudding processed in hammer mills This effects marked improvement in texture, and the product is much more convenient to handle Moreover, being comparatively fine, it may be fed to young chicks

Dried Processed Waste As its name implies, this is pudding dried and ground into a meal It can thus be fed in dry mashes It will keep a long time if stored in a dry place The meal has a high fibre content The salt content is often high These factors limit its usefulness The mash should not contain more than 15 per cent of this foodstuff

None of the foods derived from household waste, however processed can be regarded favourably for poultry feeding They are used on few farms to-day because other foods are more economic

Dried Whey This is a carbohydrate rather than a protein

food and should not be compared with dried skimmed milk. Its protein content is about 13–14 per cent, whereas that of dried skimmed milk is over 30 per cent. Whey may be used to replace middlings up to a level of 10 per cent. At a higher level it tends to cause scouring until the birds are accustomed to it.

Protein Concentrates. *Milk* Skimmed milk and skimmed-milk powder are extremely valuable foods. In general, their high cost makes them uneconomic except for young chicks breeding-stock and for fattening purposes.

Where skimmed milk is readily obtainable it should be given to the chicks to drink *ad lib*. In that event no other protein concentrate is necessary for pullet chicks reared for laying or for chicks intended for the large-table-bird market.

For chicks that are to be marketed at broiler weights or below, however, a milk and cereal diet, even when supplemented with fat and certain amino-acids in which milk is somewhat deficient will not produce growth rates equal to those obtained when a modern high quality diet is fed

For rearing pullet chicks skimmed milk should be given to drink *ad lib* to 10 weeks of age; thereafter quantity of milk should be restricted and water provided *ad lib.*, otherwise consumption of milk will be excessive to protein needs.

Skimmed milk is deficient in the fat-soluble vitamins A, D3, E and K, but it is well-off in water-soluble vitamins of the B

As a cereal mixture will usually contain 10–12 per cent crude protein, and assuming that it is of such quality that the birds do not consume more than 5 oz per head daily, the consumption of liquid skimmed milk could be restricted to $4\frac{1}{2}$ gal per 100 birds without fear of lowering egg production, but drinking water will be needed

On the basis of its protein content only skimmed milk at 4*d* a gallon is equivalent value to fish meal at about £60 a ton and extracted soya-bean meal at about £46

At the prevailing (1959) price of $4\frac{1}{2}$*d* a gallon skimmed milk is equal in value to fish meal at £68 and soya-bean meal at £52 a ton

When milk is fed in liquid form the drinking vessel must be kept clean Sour skimmed milk is equally valuable provided souring is not so far advanced that the milk may be described as putrid Chicks will consume both fresh and sour skimmed milk equally readily, but a sudden change to sour-milk feeding should be avoided, as it is apt to cause scouring

Neither liquid milk nor buttermilk should be fed in new galvanized containers, because the acid in milk will attack the galvanized surface and produce free zinc, which is toxic to poultry if the diet contains more than 100 parts per million

If new galvanized containers are used they should be treated with an acid-resisting paint

Galvanized troughs that have been used for water over a considerable period may be used for milk without adverse effect on the stock

Difficulties arise when feeding liquid milk with modern watering systems, but they can usually be overcome by having two low-pressure tanks instead of one, so that each can be cleaned in turn All pipes should be readily detachable for cleaning

Where milk is fed through pipes it should be treated while fresh with formalin The addition of 0 05 per cent formalin will prevent curdling for some days When liquid milk is given to drink it is difficult to prevent contamination by flies This may result in tape-worm infestation

Dried skimmed milk is more commonly employed in the chick-mash

Milk in some form should be regarded as desirable for birds

Every sample must be judged on its merits. The chief danger lies in an excess of oil and/or common salt, especially in samples of herring meal.

Condensed Fish Solubles. Strictly speaking, condensed fish solubles should not be regarded as a protein concentrate. Although they usually contain from 32 to 38 per cent protein they are fed primarily for the purpose of furnishing the animal protein complex in diets containing only vegetable protein. It will be sufficient to include 2½–5 per cent C.F.S. in mashes of this type.

Condensed whale solubles are also available.

Meat Meal, Meat-and-bone Meal. Meat meal is the residue from the manufacture of meat extracts. It is a useful but expensive food for poultry. It is deficient in mineral matter and must be supplemented with minerals to ensure a balanced diet.

Meat-and-bone meal is obtainable at an economic price. A good sample will contain about 60 per cent protein and about 22–23 per cent minerals. It is an excellent source of calcium and phosphorus. It is commonly used as the protein concentrate in the mash, either alone or in combination with animal and vegetable protein-rich foods.

Samples containing an excess of oil should be avoided, as they quickly become rancid. Inferior samples contain much hair and gristle, and a large proportion of bone. Frequently the bone is very coarse. This foodstuff should be purchased on its analysis.

Liver Meal. This meal is usually too expensive for commercial use. Its protein content is high—about 60 per cent—and it is a very rich source of the B group of vitamins including riboflavin. In certain circumstances it may be beneficial to use up to 5 per cent in diets for breeding stock and chicks, but cheaper sources of animal protein and vitamins are usually available.

Green-cut Bone Meal. This is fresh bone put through a cutting-machine that reduces it to a coarse meal. It is not an ideal food for poultry. Its protein is of low biological value and its high phosphorus content encourages perosis. Moreover, it decomposes rapidly, especially in hot weather. As it should be fed in fresh condition regular supplies at short intervals are essential.

Soya bean Meal Extracted soya bean meal is commonly used for poultry feeding It is a very valuable protein concentrate but requires supplementing with minerals and a source of the animal protein factor and some of the amino acids, notably methionine It may partially replace other protein rich foods indeed in many diets for all classes of poultry this meal provides 50 per cent or more of the protein concentrates

For laying stock on range of good quality this meal could replace the whole of the animal protein food in spring and summer when the birds can supplement their diet with natural foods

For growing and adult stock kept in confinement, however, 4–5 per cent of the protein concentrates should be derived from animal sources, while as a general rule 50 per cent of the protein concentrates in chick mashes should be of animal origin

Soya bean meal should be finely ground Samples containing coarse husk should be avoided

Earth nut Cake Meal Extracted earth nut (pea nut) cake meal is of very similar composition to extracted soya bean meal

These foods, however, should not be regarded as interchangeable, because although the protein content is about the same in both meals (approximately 44 per cent), the quality of the protein in extracted soya bean meal is superior to that of extracted earth nut meal The former provides about twice as much lysine, three times as much glycine and is a better source of methionine and tryptophane than the latter

The protein of soya bean meal is also more digestible than that of earth nut meal

Linseed Meal This product is much favoured by fanciers because it imparts a sheen to the plumage of the birds It is frequently recommended for feeding during the moult, but its value for this purpose appears to be over rated An average sample contains about 4 per cent fat, 35 per cent protein 33 per cent carbohydrates It is of considerable nutritional value, but its cost is usually so high that it is uneconomic for poultry feeding Four per cent in the mash is adequate

Peas and Beans These foods are of value as a source of protein of which peas contain about 22 per cent beans about 25 per cent

comes mature so its value deteriorates This is clearly seen in the following table (after Warington).

TABLE 36

Composition of Meadow Hay Harvested at Different Dates

Date of Cutting	Crude Protein	Fat	Soluble Carbo hydrates	Fibre	Ash
May 14	17 7	3 2	40 8	23 0	15 2
June 9	11 2	2 7	43 2	34 9	8 0
June 26	8 5	2 7	43 3	38 2	7 3

It will be noticed that as the grass matures the fibre content increases, while the percentage of protein decreases More-over, older grass is less digestible and palatable than the younger shoots It should be added that the vitamin content shows progressive deterioration with age.

While there is general agreement on the value of young grass, the extent to which good range will contribute to the ration of the birds is a more debatable point It has been stated that up to 10 per cent or more of the food may be saved by providing grazing of high quality In making estimates of this kind care must be exercised to distinguish between the amount of grass consumed and the food it represents on a dry-weight basis

Fresh grass contains approximately 80 per cent of water, therefore 5 oz of fresh grass are equivalent to about 1 oz of dry food

If for the present purpose it is assumed that the daily food intake of a laying bird is 5 oz (dry weight) and sufficient grass is consumed to save 10 per cent of the food, she must eat 2½ oz of fresh grass per day, together with 4½ oz of dry mash or grain That would be a feat beyond her accomplishment

If the calculation is made on a dry-weight basis, as it must be to present a true picture, about 2½ per cent saving may be effected by the consumption of fresh grass of good quality

This is an essentially practical question, and therefore its everyday difficulties must not be ignored On some farms on which extensive methods are practised the amount of poultry-

food consumed by wild birds more than counterbalances reduced consumption by the stock; so much so that some poultry-men having had experience with all systems of poultry-keeping have found that the cost of feeding birds in laying-batteries is actually less than on range. This may apply to individual farms, but in ordinary circumstances it should be possible to effect some economy in feeding when the birds have range, provided that the grass is kept in good condition.

Lawn Clippings. Dried lawn clippings constitute a useful winter food for poultry. If well cured, the clippings will have approximately the same composition as grass meal. The clippings should be about 1 in. long so that no further cutting will be necessary to make them suitable for growing and adult stock.

Samples should have a slight fish-like odour They should not be rancid. The colour should be amber, a reddish tinge should be regarded with suspicion

Veterinary cod-liver oil of good quality has a high vitamin content and it is unnecessary to purchase the more expensive samples prepared for human consumption

Cod-liver oil should be stored in a cool place and should not be exposed to air or light as the vitamins are unstable, especially vitamin A, which oxidises readily unless stabilized

The stability of vitamin A in cod-liver and other fish oils is a matter of great practical importance

Many investigations have been carried out, and these have provided evidence of loss of potency which may be very rapid

Temperton (1947) found that the whole of the vitamin A in fish-liver oils when mixed with mashes may be destroyed during twenty-four hours of storage, due to the presence of an unidentified oil soluble factor in basal mashes He concluded that "Preformed vitamin A (fish liver oil origin) is an unreliable source of the vitamin when included in mash mixtures for adult birds and growing chickens"

In experiments at the Poultry Research Station, Houghton, Hunts, complete destruction of vitamin A occurred in five days in sealed and unsealed samples of mixed food containing complete mineral mixtures, whereas mixed rations without minerals retained 50 per cent of the initial vitamin A content after fifty-six days of storage under identical conditions

The amount of vitamin A in ready-mixed mashes is usually sufficient to give protection despite progressive loss of potency provided the mash is stored under suitable conditions for a period not exceeding eight weeks

Vitamin A (carotene) in grass meal is much more stable Temperton (1948) has shown that 5 per cent of the lowest grade of grass meal used in his experiments gave satisfactory results when fed to chicks and growing stock

Synthetic forms of vitamin A, in which the vitamin is stable, are now available

Vitamin D3 in cod-liver and other fish-liver oils is far more stable than their vitamin A content and if oil of the

physical condition. These are factors of great practical importance.

Palatability cannot be predetermined. It must be assessed by feeding trials. The inclusion of a small proportion of an unpalatable food may destroy the value of the complete ration by lowering consumption. The sudden introduction of such foods as blood meal or rye meal will have this effect, at least until the birds are accustomed to them.

Physical condition of the food affects its palatability, and therefore usefulness. Birds do not relish finely ground meals, particularly when they are fed in a dry state. Very fine meals may clog in the beak, causing necrosis. They also tend to form a solid mass in the digestive tract, preventing the proper mixing of the digestive juices with the food. This may lead to

Average Composition of Common Feeding-stuffs.

Feeding-stuff.	Dry Matter	Protein		Carbohydrates.		Oil		Fibre.
		Crude.	Digestible	Soluble.	Digestible	Ether extract.	Digestible.	
Grains and Seeds:								
Barley (and barley meal)	85·1	10·0	7·6	66·5	60·9	1·5	1·2	4·5
Beans (and bean meal)	87·5	25·4	20·1	48·5	44·1	1·5	1·2	7·1
Buckwheat	85·9	11·3	8·5	54·8	42·5	2·6	1·9	14·4
Dari	85·9	9·6	7·7	71·2	60·5	5·8	5·0	1·9
Hempseed	91·1	18·2	13·7	21·1	16·8	51·6	29·5	15·0
Linseed	92·8	24·2	19·4	22·9	18·3	56·5	54·7	5·5
Maize (and maize meal)	87·0	9·9	7·1	69·1	65·7	4·4	5·9	2·2
Oats (and Sussex ground oats)	86·7	10·5	8·0	53·2	44·8	4·8	4·0	10·3
Peas	86·0	22·5	19·4	55·7	49·9	1·6	1·0	5·4
Rice (polished)	87·4	6·7	5·8	78·0	73·8	0·4	0·2	1·5
Rye	86·6	11·5	9·6	69·5	65·9	1·7	1·1	1·9
Soya beans	90·0	33·2	29·5	50·5	20·8	17·5	15·8	4·1
Sunflower seed	92·5	14·2	12·8	14·5	10·3	52·3	50·7	25·1
Wheat (strong varieties)	87·9	15·0	11·4	69·6	64·0	2·2	1·2	1·6
Wheat (weak varieties)	85·5	9·5	8·4	73·8	67·8	2·0	1·2	1·7
Cereal Products, Etc.:								
Biscuit meal	90·6	13·9	12·5	74·6	65·5	0·7	0·6	0·3
Brewers' grains, dried	89·7	15·5	15·0	45·9	27·6	6·4	5·6	15·2
Earthnut cake meal (decorticated)	89·7	46·8	37·6	23·2	18·6	7·5	6·7	6·4
Linseed cake meal (English)	88·8	29·5	25·3	35·5	25·5	9·5	8·7	9·1
Linseed cake (Foreign)	89·0	32·5	27·8	37·2	25·8	9·9	9·1	8·7
Linseed meal (extracted)	88·2	35·7	30·8	33·9	27·2	3·1	2·8	9·0
Maize germ meal	89·3	15·0	10·4	55·1	45·8	13·5	12·8	4·1
Maize gluten feed	89·6	23·5	10·0	56·7	49·3	5·4	2·7	3·5
Maize gluten meal	90·9	35·5	30·6	47·5	42·0	4·7	4·4	2·1
Malt sprouts	90·0	24·4	19·9	42·4	10·9	2·0	1·5	14·0
Oat feed (ordinary)	91·0	5·5	—	52·5	—	2·4	—	27·6
Oat feed (high grade)	91·0	10·3	—	53·7	—	5·0	—	17·5
Oat husks	94·0	2·0	—	54·0	19·1	1·0	0·4	33·0
Palm kernel meal (extracted)	90·0	19·0	17·1	49·0	43·5	2·0	1·9	16·0
Soya bean meal (extracted)	85·7	41·7	40·3	31·9	24·7	1·5	1·4	5·1
Sunflower cake	90·4	37·4	33·6	20·4	14·6	13·8	11·2	12·1
Wheat bran	86·4	13·5	10·6	53·0	35·0	3·9	2·8	10·6
Wheat middlings (fine)	87·3	15·7	13·2	64·0	52·0	3·4	3·0	1·8
Wheat middlings (coarse)	86·5	16·4	13·5	56·2	43·5	5·0	4·3	5·3
Wheat pollards	86·7	14·5	11·6	55·6	44·3	4·8	4·0	7·7

or three times a day, they were unable to eat and digest sufficient to provide adequate nourishment.

Judiciously employed bulky foods, like bran, are ideal for maintaining the stock in the best condition.

With regard to the grain ration. Maize is a more concentrated food than oats, and contains a higher percentage of carbohydrates than either wheat or oats. If the birds are losing weight it should be fed liberally, but more sparingly if they are getting over-fat.

In compounding diets the practical poultry-man need not concern himself with trace elements or those vitamins which a diet of average composition will provide in abundance. He is mainly concerned with the quality and quantity of protein, vitamins A, D3, possibly riboflavin, and calcium and fibre.

The provision of protein is usually the most important practical problem and the average poultry-man has given more thought to this constituent of the diet than any other.

Readers who wish to make simple computations to assure themselves that the diet is not deficient in protein or contains an excess of fibre—the most common errors in feeding—should work on the following lines:—

TABLE 37

Calculation of Protein Content of Diets

Layers' Mash Food.	Percentage protein.	Amount of food in mash, lb.	Protein provided.
Bran	15	20	3·0
Middlings	16	40	6·4
Ground oats	10	10	1·0
Yellow maize	10	18	1·8
Fish meal	60	12	7·2
		100	19·4 per cent

The above mash contains 19·4 per cent protein and if fed with an equal weight of grain consisting of equal parts of wheat (12 per cent) and maize (10 per cent protein) will provide a diet having 15·2 per cent protein.

The amount of fibre in the diet is calculated on the same lines thus:—

examples being given in each group:—

(1) Carbohydrates: All the cereal meals.
Biscuit meal.
Tapioca meal.
Potatoes.
Middlings (Weatings).
Whey.

(2) Protein concentrates: (*a*) Animal: Fish meal.
Meat-and-bone meal.
Whale meal.
Fish offal.
Milk.
Buttermilk.

(*b*) Vegetable: Pea and bean meal.
Extracted soya-bean meal.
Extracted decorticated earth-nut meal.
Unextracted yeast.

(3) Bulky foods: Bran.
Grass meal.
Oat-husk meal.
Fresh greenstuff.

Many foods in each group are interchangeable: for example, barley meal may replace ground oats, biscuit meal may replace wheat meal and potatoes may replace other foodstuffs in this group in the ratio of 4 lb. potatoes to 1 lb. meal. Similarly meat-and-bone meal of good quality (55 per cent protein) may replace fish meal, grass meal may partially replace bran.

All-mash Diets for Chicks (day-old to 8 weeks).[1]

(1) 15 lb. Bran.
30 ,, Middlings.
21 ,, Yellow maize meal.
15 ,, Ground barley.
6 ,, Fish meal.
6 ,, Dried milk.
5 ,, Dried yeast (unextracted).
2 ,, Limestone flour.
½ ,, Common salt.
½ pt. Cod-liver oil (or appropriate amount of synthetic vitamin A and D_3 concentrates).

[1] See p. 330.

(2) 5 lb. Grass meal.
30 ,, Coarsely-ground wheat.
30 ,, Yellow maize meal.
10 ,, Ground barley.
8 ,, Fish meal.
6 ,, Ex. soya-bean meal.
5 ,, Dried milk.
3 ,, Dried yeast (unextracted).
2 ,, Limestone flour.
½ ,, Common salt (manganized).
¼ pt. Cod-liver oil (or appropriate amount of synthetic D_3 concentrate).

Farmers wishing to make use of home-grown oats may be unable to reduce the grain to a fine meal in their mills. In that event it may be roughly crushed or broken, when the chicks will pick out the kernels, leaving the husk. Growing stock are of course capable of dealing with oats ground in the average farm mill.

If chick grain mixtures are fed in approximately equal weights along with the above mashes, the protein content of the latter should be increased to about 21 *per cent*. Proportionate increases must also be made in mineral and vitamin supplements where the mash contains these materials. The proportion of grass meal should also be increased but should not exceed 8 per cent in chick mashes.

Thus mash formula (1 would then read:—

3 lb. Limestone flour.
2 ,, Steamed bone flour.
$\frac{1}{2}$,, Common salt (man[illegible]
1 pt. Cod-liver oil.

If the chicks have skimmed milk to drink [illegible] of [illegible] the protein concentrates in each of the above [illegible] be omitted. This does not apply to broiler-chick [illegible]

Cod-liver oil (or vitamin concentrates) will not be required if an outdoor run is available when the chicks are a few days old. Grass meal may be omitted if the chicks have access to an abundance of short, fresh grass. It may be replaced with an equal weight of bran.

Some rearers feed chick grain only for the first few days, but there is no evidence that it is advantageous, provided a diet of average composition is fed. Grain feeding for a short period will help to prevent "pasting-up" due to the use of diets having a high percentage of extracted soya-bean meal, but mashes of this type are not fed in this country.

Pasting-up, *i.e.*, the accumulation of fæcal matter around the vent is usually due to chill, bacillary white diarrhœa or errors in feeding. It can occur with diets containing a high proportion of any food which is finely ground, low in fibre or with a predisposition to stickiness *e.g.*, finely ground wheat, tapioca meal and similar foods as well as soya-bean meal.

When the chicks are about eight weeks old a growers' mash should be gradually introduced. Mix the growers' mash with the chick mash in increasing proportions until in the course of about a fortnight growers' mash only is being fed.

The amount of protein in growers' diets should be about 15 per cent and the more expensive protein concentrates—milk products and yeast—may be replaced with cheaper meals.

Growers' Mashes (all-mash diets; from 8 to 18–20 weeks).[1]

(1) 15 lb. Bran.
5 ,, Grass meal.
40 ,, Middlings.
22 ,, Yellow-maize meal.
10 ,, Ground oats.
5 ,, Fish meal.
2 ,, Limestone flour.
1 ,, Steamed bone flour.

[1] See p. 330.

25 lb Yellow-maize meal
8 ,, Ground oats
12 ,, Fish meal
½ ,, Common salt
1 pt. Cod-liver oil

(2) 5 lb. Grass meal
30 ,, Coarsely-ground wheat
20 ,, Ground barley
25 ,, Yellow-maize meal
12 ,, Fish meal.
6 ,, Ex soya-bean meal
2 ,, Steamed bone flour
½ ,, Common salt (manganized)
1 pt. Cod-liver oil

Layers' Mashes (all-mash diets)
Suitable for battery egg production.

(1) 5 lb. Grass meal
10 ,, Bran
35 ,, Middlings
30 ,, Yellow-maize meal
15 ,, Ground barley.
5 ,, Fish meal
½ ,, Common salt.
½ pt. God-liver oil.

(2) 5 lb Grass meal.
30 ,, Coarsely-ground wheat.
30 ,, Yellow maize meal
25 ,, Ground barley.
5 ,, Fish meal.
5 ,, Meat and bone flour.
½ ,, Common salt (manganized).
½ pt. Cod-liver oil.

Breeders' Mashes (for use with grain).

(1) 5 lb Grass meal.
10 ,, Bran.
35 ,, Middlings
21 ,, Yellow-maize meal
10 ,, Ground oats
8 ,, Fish meal.
5 ,, Yeast (unextracted).
4 ,, Dried milk.
2 ,, Steamed bone flour.
1 ,, Common salt.
1 pt. Cod-liver oil

(2) 10 lb. Grass meal.
30 ,, Coarsely-ground wheat
25 ,, Ground barley.
10 ,, Ground oats
6 ,, Fish meal
6 ,, Meat and bone meal
6 ,, Yeast (unextracted).
½ ,, Earth-nut meal.
3 ,, Steamed bone flour.
1 ,, Common salt (manganised).
1 pt. Cod-liver oil.

A suitable grade of insoluble grit should be provided with all the above mashes. The mashes provide sufficient calcium for chicks and growing stock but not for layers. The latter *should have oyster shell or limestone grit ad lib.*

The following mashes are in use at the National Institute of Poultry Husbandry (1959):—

Composition of *Home-mixed Diets in Use at the N.I.P.H.—April 1959*

Diet	Dual purpose balancer	Battery layers	High energy battery layers	Hen breeders balancer
Class of stock	Growers 12 weeks to maturity All layers	Battery birds	Battery bird	Hen breeding and duck breeding stock
Yellow maize meal	27 *	30	34	28
Medium/coarse ground wheat	42	36	45	37
Ground barley	—	10	—	—
Grass meal	4	3	—	4
White fish meal	3	5	6	8
Meat and bone meal	5	—	—	—
Extracted soya bean meal	10	10	10	7
Unextracted dried yeast	—	—	—	5
Dried skim milk	—	—	—	3
"Beta Ferm" dried solubles	—	—	—	—
Limestone flour	3	1½	2½	2
Steamed bone flour	2½	2	—	1½
Dairy salt	½	½	½	½
Premix No 1 (D_3)	2	—	—	—
Premix No 4 (A + D_3 + B_2)	—	1	1	2
Premix No 5 (manganese)	1	1	1	2
	100 Mash + Grain	100 All Mash	100 All Mash	100 Mash + Grain

* Can be maize or barley, or mixture of these cereals

BALANCER DIETS USING MASH + GRAIN

GRAIN —Fed in equal proportions by weight to mash Composition of grain or grain mixture dependent upon availability and price At N I P H wheat alone is used

PREMIXING ROUTINES

Premix No	Supplement	Quantity		Base
1	Vitamin D_3	2½ lb Trelco	*	47½ lb Maize Meal
2	Nitrofurazone	½ lb Pure		50 lb Maize Meal
3	Procaine Penicillin	15 gm		50 lb Maize Meal
4	Vitamins A D_3 B_2	EITHER 1 lb Trecolvite OR 1 lb Beta No 18	†	15 lb Maize Meal
5	Manganese 98/99% commercial	1¼ lb $MnSO_4$		54¾ lb Maize Meal

* 1 million I C U per lb

† 4 million I U Vitamin A per lb; 1 million I C U Vitamin D_3 and 2 gr B_2 per lb

Each of the above premixes included at 1 per cent level will provide approximately

PREMIX No 1 —500 units D_3 per lb of feed

PREMIX No 2—0·01 per cent nitrofurazone
PREMIX No 3—6–7 gm per ton penicillin
PREMIX No 4—2,500 international units vitamin A 625 I.U., vitamin D3 1·25 m/gm B2 per lb
PREMIX No 5—25 mg available manganese per lb (or 8 oz manganese sulphate per ton of feed).
Several firms supply the above supplements for adding to home-mixed diets. The supplements vary in potency, which is stated by the manufacturers

If fish meal is replaced by meat-and-bone meal in the above mashes the latter should contain not less than 55 per cent protein. Should lower protein meals be used the proportion should be increased to provide the same amount of protein as that provided by fish meal of good quality.

In spring and summer when an abundance of short grass is available grass meal may be replaced with an equal weight of bran or ground oats.

For breeding stock the basal grain ration may consist of equal parts of wheat (or barley), oats and yellow maize, but should be varied in accordance with the condition of the stock.

In normal circumstances birds should be fed to appetite. No attempt should be made to restrict food consumption unless it is desired to induce moulting.

No-protein Diets. Diets containing no protein concentrates of any kind are usually called no-protein diets. In fact, of course, mixed cereals will show about 11 per cent protein and a simple mash consisting of grass meal, ground wheat, ground oats or ground barley will contain sufficient protein to maintain 35–40 per cent egg production or about 130–150 eggs per bird, provided it contains the essential vitamins and mineral matter.

Laying stock on grass range of good quality will find additional protein in the grass and soil. This explains the fact that in many instances high or comparatively high egg production has been secured by the use of no-protein diets and under similar conditions growing stock will make satisfactory progress. But unless range conditions are exceptionally favourable it is wise to include a proportion of animal protein in diets for all classes of stock

(3)	Sussex ground oats	6½	,,	
	Barley meal	6½	,,	,
	Dried skimmed milk	1	,,	,
	Water	20	,,	
(4)	Sussex ground oats	6½	,,	,,
	Fine middlings	6½	,,	,
	Dried skimmed milk	1	,,	
	Water	20	,,	,,

For cramming, 1 part of mutton-fat should be added to the above mixtures

Mashes Containing Potatoes During the war potatoes were used extensively for poultry-feeding They should be washed and then boiled or steamed When included in the chick-mash they should be peeled

Halnan and Fermor (1942) reported in *Agriculture* that the following chick-mash gave satisfactory results at the Southern Section of the National Poultry Institute, Wye, Kent —

80	lb	Potatoes
20	,,	Middlings
3	,,	White-fish meal
2	,,	Dried yeast
0 4	,,	Cod liver oil
1	,,	Chalk

In a series of feeding trials with laying-stock they found the following formula successful —

80	lb	Potatoes
20	,,	Middlings
3	,,	White fish meal
3	oz	Common salt

Mixing Cod-liver Oil. Manufacturers supply mashes containing cod-liver oil, and it is advisable when buying ready-mixed mashes to have the oil mixed in at the mill

If oil is added on the farm a modern mixer will ensure even distribution It should be poured over the mixing blades while the machine is operating

In the absence of a mixer the requisite quantity of oil should be poured over a small proportion of the bran, maize meal or mash and thoroughly mixed by rubbing up by hand It is easier to mix with bran than with a fine meal

The oil-impregnated food should then be mixed with the bulk of the mash.

Hand blending oil with mash is tedious work.

Some prefer to mix the oil with the grain feed. This should be done daily—immediately before feeding the grain.

One pint of cod-liver oil per 100 lb. of food (weighed dry) or 1 tablespoonful per 3 lb. is approximately equivalent to 1 per cent.

Weight of Food Consumed by Adult Stock. The amount of food consumed by adults is approximately 4½–5 oz. (weighed dry) per bird per day, but it should be stressed that this is merely a round figure that should not be regarded as a hard-and-fast rule.

Unfortunately, there is a tendency for inexperienced poultry-keepers to accept this as the correct amount of food, which they carefully weigh for each meal. *This procedure results in over-feeding or under-feeding—always in uneconomic feeding.*

Feeding is not a matter of weighing the food and serving it in definite amounts. Feeding is essentially a matter of observation. The birds should be fed in accordance with their appetites, just as the composition of the ration should vary in accordance with their condition.

mash consists of water. When wet mashes are fed the birds do not drink so much water

Consistency of Wet Mash. Although it is customary to speak of wet mash, the mash should be fed in a crumbly-moist condition Only a small quantity of water should be added to the dry meal—just sufficient to make it hold together when pressed between the hands It should break up when thrown to the ground

This is the correct consistency for all wet mashes except those used for trough-feeding and cramming, which should be mixed to the consistency of thick cream

Poultry Manure. Compared with farmyard manure, poultry manure is a valuable fertilizer, rich in nitrogen, but deficient in potash It is essentially a nitrogenous manure

Before the last war it was said to be worth £3 or £4 per ton Despite this, many poultry-men found the greatest difficulty in disposing of this by-product, and in some areas it could not be given away

Much prejudice still persists against the use of poultry manure, largely because it does not receive due attention on the poultry-farm or is not properly utilized One difficulty is that of ensuring even distribution over the land This is solved by the folding system, and that is why farmers employing this system recognize the value of the droppings

On the average poultry-farm the material is simply dumped on the manure-heap, where it is washed by rain Here much of the nitrogen is lost, and the manure becomes a soggy mass which cannot be evenly spread

If its value is to be conserved, it is essential to store the manure under cover, and if possible it should be spread in shallow layers to air dry before being stored in bulk

Composition of Poultry-manure The composition of poultry-manure is variable An average sample of the fresh manure contains approximately 55 per cent water, 29 per cent organic matter, 2 per cent nitrogen, 1 2 per cent phosphates and about 0 6 per cent potash An air dried sample contains about 15 per cent of moisture

Manure Voided by Fowls The total weight of manure voided by fowls is about twice the dry weight of food consumed With an average food intake of 5 oz per day or 1 cwt per

annum, the total weight of manure excreted by a flock of a 100 birds is 10 tons per annum. This would contain nitrogen equivalent to almost 1 ton of sulphate of ammonia, the phosphates contained in just over 7 cwt. of superphosphate (30 per cent) and potash equal to that in nearly 2½ cwt. of muriate of potash.

Ling and Muir (University of Bristol) have pointed out that if 10 per cent of superphosphate is mixed with the manure, or 7 lb. per 100 birds per week, and the droppings are then stored for a month, they break down into a friable condition, free from smell. Moreover, droppings so treated and stored under cover have a high nitrogen content.

Composition of Deep Litter. The physical and chemical properties of deep litter were studied at the National Institute of Poultry Husbandry for a period extending over several years.

Litter consisted of soft wood shavings, to which in some cases hydrated lime was added.

It was reported (1951) that within one month the nitrogen content of the litter can be as high as 2–3 per cent, with an average of 1·5 per cent.

In litter one year old the average nitrogen content was 2·1 per cent, and the second year the same litter showed 2·4 per cent nitrogen, declining to 2·1 per cent in the third year.

There was a gradual build-up of phosphorus (P_2O_5) from 1·3 per cent after one month to 3·4 per cent in the second year, this level being maintained in the third year.

After one month the litter contained an average of 0·8 per cent potash (K_2O), rising to 1·1 per cent at the end of the first year and 1·8 per cent during the second and third years.

It was calculated that the application of 1 ton per acre of deep litter would provide.—

Chapter Eighteen

Table-poultry Production

ALTHOUGH the poultry industry in this country developed very rapidly in the years following the 1914–18 war, it was built up largely on the production of commercial eggs. Comparatively little attention was paid to the possibilities of table-poultry production.

It is true that specialized production was carried out in certain areas, notably that of the Heathfield (Sussex) district, but this trade was concerned with placing on the market the white-skinned "Surrey" chicken finished by a course of trough-feeding and cramming. The "Surrey" chicken, however, although of superb quality, has a restricted market because it is a luxury article. That will long remain so.

The average poultry-farmer made no attempt to put table-poultry production on a sound commercial basis. He was prepared to dispose of his surplus cockerels in mixed lots in the local market or to sell them on the farm to a dealer. The result was that little, if any, profit was obtained from these birds, and the foreigner who carefully graded and packed his birds to meet the requirements of buyers captured the bulk of the trade of the large wholesale markets. That was deplorable, but nevertheless inevitable, because with few exceptions the home producer made no effort to supply the buyer with the kind of material he required.

A visit to any of our city markets revealed the inferior finish, grading and packing of home-produced birds, as compared with the imported product. Yet the "Surrey" chicken, the product of our fattening-yards, has always been the finest table-bird. We beat the foreigner in catering for the limited market demanding this type of chicken, but he beat us in the production of country chickens for which there is a very large market indeed.

In the 1930s the possibilities of table-poultry production by the poultry-farmer mainly concerned with commercial eggs was becoming more widely recognized, and considerable progress was made until war prevented further development. The specialized production of "country chickens", or birds marketed "off the run", without being given a course of trough-feeding, was receiving more and more attention. In those days it was customary to rear cockerels to about sixteen weeks old when they reached $3\frac{1}{2}$–4 lb. dead weight. Many

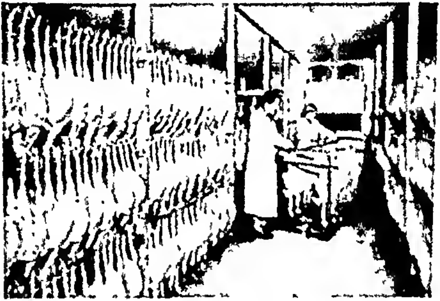


Photo [illegible] Ltd

were decontrolled on July 1st, 1950, that the home-table poultry trade began to revive.

It can be said that decontrol of prices and subsequently of feeding-stuffs marked the beginning of a new table poultry industry in this country Since that time tremendous progress has been made both in production and marketing Broiler production, i e, the mass production of ten-week-old chickens reared in large groups in total confinement, has become a specialist section of the industry

Parallel with this development, great advances have been

Photo Polpak Distributors Ltd

FIG 153—GRADING AND PACKING TABLE POULTRY

effected in processing and marketing Indeed, in many respects modern methods bear little resemblance to those employed in the past

It must not be assumed that all table poultry producers have put their house in order Large supplies of birds ungraded and not properly packed continue to reach the markets, where, of course, they realize low prices, but specialist producers are setting an example in production and marketing which is being followed on an ever-widening scale

Poultry packing-stations, both privately and co-operatively owned, have been and continue to be established in many parts of the country At these stations the birds are killed, plucked, cooled, graded and packed and delivered in cases bearing the

packer's mark or trade name to large wholesale and retail buyers The packing stations are equipped with refrigerators, some with deep-freezing plant

Many stations eviscerate (draw) the birds and prepare them for the oven The sale of oven ready birds is now a feature of the market, many millions being sold annually, the majority being broiler chickens

Oven ready birds are wrapped individually in transparent or semi transparent film in the form of a sealed bag a stretch wrap or diagonal wrap They are then deep frozen and subsequently held in cold store (0 to −5 F) prior to delivery to buyers

Wrapping clean plucked uneviscerated birds individually is now undertaken on an extensive scale In common with the oven ready product, they are usually packed in dozens in cardboard or wooden boxes

But uneviscerated birds—particularly hens—are frequently marketed unwrapped They are clean plucked and packed in boxes lined with greaseproof paper

trade may be developed, however, to provide an important outlet

At some processing stations a proportion of the birds are cooked, wrapped and frozen This is not a common activity of the stations, but large supplies of eviscerated chickens, mainly in the poussin and broiler classes, are now cooked on spits in shops and restaurants

Chickens roasting in shop windows have become a familiar spectacle. They are either consumed on the premises or wrapped in aluminium foil which will keep the birds serving hot for a short time

Table-poultry marketing is now largely in the hands of processors Poultry processing and marketing are highly specialized activities, and the average producer is advised to dispose of his produce through a packer rather than attempt to establish his own processing and sales organization

Small scale producers may be justified in selling direct to consumers and/or to local shops In certain circumstances sales of this kind may provide a remunerative side line, but producers with a substantial output should leave processing and marketing to specialists

To day co operation between the commercial producer and packer is essential Supply and demand are so finely balanced that the market cannot absorb a sudden influx of supplies

Market Requirements. Producers with a sufficiently large output to warrant selling direct to wholesalers and retailers should discuss with buyers the number, weight and quality of birds required and method of packing

Birds must be graded according to their weight, colour and finish Each box should contain birds of uniform quality, and details should be stated on the label on the box, so that the buyer has only to look at the label to know what the pack contains

It is not the buyer's job to grade chickens, and if producers compel him to do so by marketing mixed lots, he will charge for the work by reducing the price

Further, buyers or salesmen should know what supplies to expect It is unreasonable to send small consignments to market at perhaps infrequent intervals, then suddenly to send a large number of birds not expected by the buyer That

results in overloading the market, and of course supplies can only be cleared by a *reduction in prices, affecting every* producer

The following grades are recommended by the Ministry of Agriculture's Advisory Committee on Dressed Poultry Marketing Standards defined in Marketing Guide No 41 (1951) —

Poussin	Dead weight range from 16 to 32 oz Live weight equivalent 1¼–2¼ lb
Chicken	Two lb and over Live weight equivalent 2½ lb minimum
Surreys	Birds of 3½ lb and over Live weight equivalent 4 lb minimum
Fowls (hens)	Three lb and over Live weight equivalent 3½ lb minimum

There are quality grades for each of the above classes

Weight grades for live birds now commonly used in market reports are as follow —

Single poussin	Up to 1¼ lb
Double poussin	1¼ to 2¼ lb
Small chicken	2¼–4 lb
Large chicken	Over 4 lb
Capons	Over 6 lb
Small hens	Under 5 lb
Large hens	Over 5 lb

excluding, of course, hens The demand for chickens of about $3\frac{1}{2}$–$4\frac{1}{2}$ lb dead weight is relatively keen throughout the year, and prices are comparatively steady.

Prices are, however, subject to seasonal movements, they are usually rather high in the early spring, gradually declining until the autumn, when they rise again under the influence of the Christmas trade This is the general picture of price movements

There is also a change in demand for birds of different weight grades For example, buyers who will gladly accept birds of about 3 lb (plucked) early in the year may later want chickens of $4\frac{1}{2}$–5 lb or more

For the Christmas market very large birds are required, indeed, they cannot be too large, provided they are well finished and tender It is at Christmas-time that the demand for capons of 8–10 lb reaches its peak

Since food represents some 60–70 per cent of the total cost of production, the feed conversion ratio, i e, the weight of food required to produce a given increase in live weight, is a matter of great economic importance Feed-conversion ratio is usually expressed in terms of pounds feed required to produce 1 lb live-weight gain, and it varies with the age of the bird as shown in Table 39

TABLE 39

The Effect of Age on Efficiency of Feed Conversion (Data by Courtesy of the National Poultry Tests)—Broiler Demonstration, 1958

Entry of 8 pens of 50 cockerel chicks per pen

Age weeks	Average weight lb	oz	Food conversion ratio lb
2		5.68	1.703
4		15.80	1.919
6	1	15.78	2.127
7	2	8.85	2.225
8	3	1.32	2.363
9	3	10.36	2.590
10	4	2.20	2.801
11	4	9.29	2.977
12	5	0.04	3.125
13	5	10.57	3.245
14	6	1.52	3.461
15	6	7.34	3.631

After twelve weeks of age feed consumption per lb. gain rises steeply. It is uneconomic to feed capons after they are about six months old.

From the producer's standpoint birds are most profitable when killed at about ten weeks of age. This is the usual age for killing broilers. It enables the producer to rear about four batches a year with an interval between batches for cleaning and disinfection of plant.

Sex Differences in Growth Rate. Cockerels grow faster and convert food more efficiently than pullets. These advantages apply to heavy breeds and their crosses more so than with light breeds and light-breed crosses.

The differences in growth and feed-conversion efficiency between the sexes is shown in Table 50. Data by courtesy of *Poultry Industry.*

TABLE 50

The Four National Broiler (Random Sample) Tests—Comparison of Sexes

Capons Capons are castrated male birds The operation, which is quite a simple one, is not worth while unless very large birds weighing from 8 to 10 lb are required The demand for birds of this weight is largely confined to the Christmas season

When the testes are removed the birds become very docile, losing the restless, aggressive character of the male, and not only grow to a much larger size, but their flesh is tender and juicy

Birds may be caponized when they are ten to twelve weeks old, but there are fewer slips and lower operative mortality if caponizing is carried out at six to seven weeks of age

In recent years trials at the National Institute of Poultry Husbandry demonstrated that caponization at fourteen days of age was practicable (using specially designed instruments), but chicks of this age do not well withstand a fasting period of twelve hours, and when the intestines are distended with food the testes are obscured, consequently the work is slowed up

Caponization was also carried out at twenty eight and forty-two days of age at this centre, five to six weeks now being regarded as the best age

The beginner is advised to see the operation demonstrated by an expert or to practise on a few dead birds before operating on live ones A set of caponizing instruments will be required The number of instruments included in a set is variable, but all sets include a knife for making the incision, a spreader for holding the ribs apart, forceps, a tearing hook and an instrument for removing the testicles

The work should be done in a strong light, preferably out of doors on a sunny day A small table or box of convenient height will be needed Many use a barrel standing on its end The operating table must be perfectly rigid

The birds must be starved for twenty four hours preceding the operation but it is inadvisable to withhold water during this period Birds are secured by passing a loop of strong string around the legs and another round the base of the wings close to the body The wings should be folded over the back The ends of each string should be tied to a brick or other suitable weight, which should hang over the opposite sides of the table Alternatively, the strings may be fastened to nails projecting from the table at suitable points Thus the bird is securely held in position It should be placed on its side

Now proceed as follows Locate the position of the last two

Chemical Caponizing. In recent years the use of female hormones as an aid to fattening cockerels intended for table has received considerable attention and has largely superseded surgical caponization.

In addition to producing ova, the ovary also secretes substances known as hormones, which are carried in the blood-stream to other tissues, which they stimulate.

Photo. Harkers Veterinary Remedies, Ltd

FIG. 154.—CHEMICAL CAPONIZING

An injector for implanting hormone pellets under the skin.

These hormones, which are collectively known as estrogens (œstrus or heat periods in mammals), are responsible, among other things, for the secondary sexual characters associated with femaleness in birds. The corresponding male hormones are termed androgens.

Estrogens, when introduced into the bodies of male birds, cause them to assume female characters; they become quiet. There is an increase in the fat content of the blood and a recession of the comb and wattles. While under the influence of the hormone, cockerels do not crow.

The natural substance obtained from the ovaries and other tissues is too scarce, and the extraction process too costly, to

be of commercial value, but in 1937 a substance named diethylstilboestrol, having the same biological action as the natural hormone, was prepared synthetically by *Dodds* and his associates at the Middlesex Hospital, London

Other substances of similar type are now produced commercially, the best known being hexoestrol, a product somewhat milder in its effect than diethylstilboestrol or stilboestrol, as it is usually called

Chemical capons will attain about the same or slightly

available (the effect of hexœstrol is rather longer lasting than that of stilbœstrol), while hormones are also supplied in a cream base The cream is injected with a special instrument, the dose being accurately regulated

Injectors are now most commonly used for implanting pellets, although it is possible to operate with a sharp knife The latter method is not recommended

Implantation should be carried out four or five weeks before killing, preferably at about four weeks

Some treat the birds at about eight weeks of age for killing at twelve weeks, but caponization is of doubtful value when killing so young unless a higher price can be obtained for superior finish

Chemical caponization is more profitable when producing larger chickens of between sixteen and twenty weeks of age, when they may be as much as ½ lb heavier than untreated birds

At one time implantation was advised six weeks before killing, and in large bird production it was recommended that they should be treated at about ten weeks old and again at about sixteen weeks for killing at twenty to twenty two weeks old

Unfortunately birds so treated, unlike true capons, put on large amounts of abdominal fat, to which many buyers take exception, indeed there may be difficulty in finding a profitable market for them

For this reason the birds should be implanted once only about four weeks before killing This limits the accumulation of fat, but produces a soft, tender bird that will satisfy the requirements of the most exclusive markets

One 15-mg pellet per bird (or the equivalent dose of the hormone preparation in cream form) is adequate for birds up to about 5 lb at the time of implantation For larger birds and stock cockerels no longer required for breeding purposes two 15 mg pellets should be used Treatment of stock males will enhance their market value

The operator should work with clean hands and instrument to avoid introducing pus forming organisms which may render implantation ineffective

The effect of hormone treatment begins to disappear in

about six to seven weeks, and in due course the birds develop their normal characters.

While under the influence of the drugs cockerels do not crow, their combs and wattles remain small and pale, indeed the birds may be mistaken for culls. Fighting and bullying, however, may occur among treated birds. To obviate these troubles capons should be kept quiet and given ample space, including feeding space. Birds of the same age should be housed together.

Treading is common among treated birds because the drugs cause a recession of the secondary sex characters while the primary sex-glands remain active.

When the effect of treatment has worn off the birds may be used for breeding purposes. Some breeders declare that fertility is equal to that of untreated males.

Eaton and Carson (1955) found that treated males were only slightly less fertile than untreated birds. The most noticeable effect of the treatment was the marked reduction in the volume of semen, which was far greater than the reduction in fertility.

Breeds for the Table-poultry Producer. It is as important for the specialist table-poultry producer to select a suitable breed and a suitable strain of the breed as for the producer who is principally concerned with commercial egg production.

conversion in recent years are largely attributable to more efficient diets having a high energy value and balanced with regard to all known nutrients.

For example, in the 1930s well-reared cockerels attained an average live weight of $3\frac{1}{2}$–4 lb. at fourteen weeks old on a food consumption of 14–16 lb., *i.e.*, a feed conversion ratio of about 4 : 1.

In the early 1950s birds in this weight range were produced at the age of twelve weeks with a feed conversion ratio of about 3·5 : 1.

To-day in broiler production mixed sexes will average about $3\frac{1}{2}$ lb. live-weight at ten to eleven weeks of age and show a feed conversion ratio in the region of 2·5–2·7 : 1. In some cases more efficient feed conversion is obtained.

At the Maryland Agricultural Experimental Farm, (1959) 3-lb. broilers were produced in eight weeks on only 2·01 lb. feed per pound of broiler, while in a trial at College Park, broilers reared in batteries and fed experimental rations reached 3 lb. weight in seven and a half weeks with only 1·6 lb. feed per pound of broiler (Combs 1955).

Progress in breeding and nutrition is continuous; results secured in experimental work to-day may be common place in commercial production to-morrow.

While special table strains are being produced at present the majority of table-poultry producers must rely on breeds and crosses bred primarily for egg production, but this does not imply that table qualities should be ignored. On the contrary, they must be considered in order to secure the most economic production both of eggs and poultry.

A high feed conversion ratio and attractive body conformation are not incompatible with high egg production, and the breeder producing commercial strains—*i.e.*, strains from which his customers obtain their livelihood—should pay attention to table qualities when selecting his stock.

For those specializing in table-poultry production and catering for a high-class trade, white, or at any rate light coloured plumage is desirable.

Other characters of importance include high hatchability, rapid growth and feathering, reasonably fine bone carrying an abundance of soft flesh and a high proportion of breast meat.

Slow feathering and high breast bones are undesirable features of some strains.

The following are the most popular breeds and crosses for the purpose:—

The Sussex. In the forefront of the table-breeds must be placed the Sussex—the Light or White varieties. The Light Sussex is by far the most popular. This breed has long been famous for its table qualities, but it is also a good layer, and the best strains can claim with justification to be true utility fowls.

So far as dual-purpose qualities are concerned, however, strains of this breed differ perhaps more widely than those of other breeds of the utility class. At one extreme there are the coarse, sluggish birds with heavy bone, at the other, light birds in which table qualities have been sacrificed for egg production. Great care should be exercised in the selection of strain. The racy type should be avoided.

The Faverolles. This famous French breed has not become popular in this country, largely on account of its feathered leg, beard and muffing—features that have been exaggerated by the exhibition breeder. It is hardy, a rapid grower, and produces an abundance of white flesh of high quality. The breed might be more commonly used—especially for crossing—if it were bred for size and stamina and the essentially exhibition points received less consideration.

requiring $3\frac{1}{2}$–4-lb birds It is superior to the Rhode and other yellow-skinned breeds If fed on a pigment-free ration the yellowness in the flesh disappears, and when properly packed the birds compare favourably with any other breed in market presentation Unfortunately it is not usually so fertile as other utility breeds and many strains are not pure for the silver factor, consequently when crossed they may produce coloured progeny

The factor for silver (S) will not inhibit the appearance of black (melanin) pigment, but the factor I will do so, hence the ideal broiler male is IISS genotypically

Blue North Holland This is a composite breed of comparatively recent introduction Some years ago it received much publicity as a table-bird, but it has never attained great popularity Its barred plumage is against it in our markets, notwithstanding its white flesh and—from the producer's viewpoint—rapid growth At certain stages the birds have a large number of dark stubbs, which are undesirable in table-fowls

Well grown chickens of superior strain are first class table birds, and when clean plucked have a most attractive appearance

A white variety of the breed is now available which may assume greater popularity than its barred relation It may be useful in creating new table strains

Rhode Island Red The Rhode Island Red, at present the most popular of all the laying breeds, is not a first class table-bird and cannot be recommended for the specialist producer Its yellow skin, dark stubs and rather high breast bone preclude it from ranking high among table birds

Plymouth Rock The Barred Rock, the most popular variety of the breed in this country, does not appeal to the table-poultry producer on account of its barring and yellow flesh

The White variety, however, has made great headway in the United States of America and Canada, where it is employed on an extensive scale in the production of crosses It is one of the basic breeds used in creating special broiler strains

It is now attracting attention in this country, some breeders

replacing Rhode males in flocks of Sussex with White Rock males when the demand for pullets of the former cross has been satisfied. The change of *mating* is usually made in April.

In the opinion of many interested in broiler production the White Rock is likely to play a major part in this section of the industry.

The Buff Rock of a superior strain, although a prolific layer, is handicapped by its colour and fleshing qualities, but it provides first-class material when crossed with Sussex.

New Hampshire Red. This breed is a better proposition than the Rhode as a table fowl. Its conformation is superior to the Rhode, and it is not so heavily pigmented. Its chief value lies in crossing mainly with Light Sussex and White Rock.

Superior strains of New Hampshire Red are of outstanding quality for table work. Probably *the most rapid feathering* of all breeds, it carries a high proportion of meat to bone, and the meat is of fine texture.

But not all strains are of equal quality. Some are not typical of the breed. Great care should be exercised in selecting a source of stock.

The Leghorn. The Leghorn is not a table-fowl, and no method of feeding will make it one. Light-breed cockerels should be got rid of as soon as they can be sexed or run on to

birds cannot be produced from inferior material. The finer breed points are of no interest to him, but he is very much concerned with health, vigour, body-size and conformation. To secure these characters he must either breed his own stock or obtain it from a reputable source. Care in buying chicks for table-work is of primary importance.

Indian or Old English Game × Light Sussex. This cross produces chickens of the very highest class for table purposes. The Indian Game is most commonly used with the Light Sussex.

Photo Modern Poultry Keeping

FIG. 155—FOR TABLE-POULTRY PRODUCTION LIGHT SUSSEX COCKERELS MATED WITH RHODE ISLAND RED HENS IS A POPULAR MATING

Both the cockerels and pullets are silver—an advantage for table work.

The Game in its pure state is very yellow in skin and tends to be somewhat hard in flesh, but it carries quite an exceptional amount of breast-meat. When crossed with a white-skinned breed the resulting chicks are of superb quality, with well-rounded breasts having a great depth of meat of very fine texture. From 5–15 per cent of the first crosses may have yellow flesh.

It is generally agreed that Game crossed with Sussex, Buff or White Orpington, Dorking or Faverolle produces the best of all table-fowls, but unfortunately the birds are rather costly to produce, on account of the Game being less fertile than the more popular breeds.

Where a sufficiently remunerative market can be obtained,

however, this class of chicken is worth while producing, but of course the trade is a luxury one. So prepotent is the Game that even when crossed with the Leghorn it produces a table-bird of excellent quality, ready for the table when taken from the run.

In recent years the second cross with the Game has become very popular. Indian Game × Sussex mated with Sussex produces a fine table-bird that grows rapidly and will attain at fourteen to sixteen weeks of age a weight equal to or greater

cross is also used for this purpose All the chicks are, of course, silver

Good-quality Rhode × Sussex chicks can be recommended for table-work, but, since the cross is the most common of all—most breeders and hatcheries supply it—the table-poultry producer must find a supplier who can be relied upon to furnish the right type of chicken.

The reciprocal cross is also widely favoured Chicks of this cross are now in more plentiful supply than formerly because so many egg producers keeping their flocks on intensive systems prefer birds of light plumage Hence the demand for Sussex × Rhode, *i e*, the silver pullet, has increased, consequently more cockerels of this cross are available for table-poultry production

Sussex × White Wyandotte This cross is a good one for the country chicken trade, but is not recommended for the production of " Surreys " because a proportion of the birds have dark stubs, and with some strains the breast-bone is rather high The Wyandotte, however, is not the popular utility breed it was thirty years ago, and few specialist producers would make use of this cross to-day, when other crosses are so readily obtained

Second crosses, always popular for table work, are now in very keen demand They include the Light Sussex × (New Hampshire Red × Light Sussex) the White Rock × (New Hampshire Red × Light Sussex) and the Light Sussex × (Rhode Island Red × Light Sussex) There are, of course, many other combinations of this type

Second crosses with Indian Game, *e g*, (Light Sussex × Indian Game) × Light Sussex, provide excellent material for the large-bird market, but for birds of the broiler or spring-chicken class Game crosses are not advised unless the Game sires have been specially bred, the original Game blood having been much diluted by suitable crossing

The White Jubilee Indian Game crosses so successful in the United States are of the latter type—very different from the Game birds seen on the show bench

Utility Strains. So far, table-poultry production has been considered from the standpoint of the specialist

The great bulk of the birds produced in this country,

however, are the product of the poultry-farmer and general farmer who is mainly concerned with egg production.

Table birds from these sources are "surplus" cockerels, culled pullets and hens, and many thousands are merely dumped on the market, often to realize extremely low prices.

If cockerels of the laying breeds are worth keeping for table, then they must be properly fed, managed and marketed. Culls from the laying-flocks may realize better prices if given a short course of fattening, and they will certainly do so if marketed in an orderly manner.

Even the despised light-breed cockerels may find a remunerative market as petit poussins, while the popular light-heavy crosses—*e.g.*, White Leghorn × Rhode Island Red, Brown Leghorn × Light Sussex—should reach 3 lb. live weight at nine to ten weeks of age, 3½–3¾ lb. at twelve weeks and 4 lb. at fourteen weeks.

Systems of Rearing Table Poultry. The various systems of rearing that have been discussed are suitable for table-poultry production, and provided the management is sound, it cannot be said that any one system or combination of systems is superior in all respects to others.

In the writer's experience, however, rearing table poultry in cages with wire floors after twelve weeks of age is not entirely satisfactory. If kept on wire after this stage it is difficult to prevent a proportion of the birds developing breast blisters on some plants the incidence is high—and although they are lanced in processing, the breast is disfigured, which usually reduces the value substantially. Furthermore, when confined to cages the birds tend to become excitable, resulting in torn backs and cannibalism.

The cage system is quite suitable for poussin production and for the smaller class of chicken. A number of large-scale battery rearing plants are successfully operated in many parts of the country.

Some producers rearing chicks over twelve weeks old in cages use slatted floors after the birds are seven or eight weeks old. In carry-on cages about 1 sq. ft. floor space per bird should be provided up to about thirteen weeks of age, e.g., a 2-ft. 6-in. × 3-ft. 10-in. cage will accommodate ten birds.

Laying-battery cages are also used, the standard cage (14–15 in. wide) will take two birds, the twin-bird cage three.

Tier brooders of all types are commonly used for the first stage of rearing, often followed by cooler cages, and when the chicks no longer require artificial heat they are either reared in total confinement on littered floors or in arks with a small slatted or wire floor veranda attached. Coccidiosis hazard is increased by putting chicks from carry-on cages on littered floors.

There is no object in rearing birds intended for table on free range. If circumstances make such a course necessary, the range should be restricted and well sheltered.

Producers without sufficient housing for rearing in confinement up to killing age may find straw-yards the best solution to their problem. The birds could be housed in arks or range shelters or, of course, yards could provide small runs for houses occupying permanent sites. In producing large birds and capons yards may be used without housing or shelter of any kind, provided the site is not exposed and, of course, provided the young growers are thoroughly hardened before being moved into open yards.

In these circumstances only sufficient perching space will be needed.

When the yard system is adopted it is advisable to make provision for resting the yards from time to time. They are liable to become foul, and so far no satisfactory short-term remedy has been found for this condition.

Extensive rearing from about six or seven weeks of age undoubtedly produces chickens that respond remarkably well to trough-feeding and cramming, but to suggest that intensively reared birds are unsuitable for these processes is not borne out by experience.

Moreover, experiments have demonstrated that the intensive system is not only a complete success, but that it has many advantages over the older methods, particularly where the available ground is very limited and where winter rearing is undertaken, as it must be undertaken by the specialist if he is not to miss the spring and early summer season.

Range-rearing is not without its difficulties. Firstly, early in the season there is considerable risk of the growth of the

young birds being checked when they are moved to arks; secondly, unless an abundance of clean ground is available, grave danger arises from internal parasites; and, thirdly, there is no evidence to show that when all factors are taken into account the financial return is greater where extensive methods are practised compared with intensive methods.

Losses on range are often greater than among birds reared in total confinement, and food consumption is usually higher owing to less efficient utilisation by range reared stock and greater wastage.

Poussin Production. Poussin production is carried out largely on mass-production lines; in many cases the birds are part of broiler crops. For instance, on some broiler plants about 3,000 chicks may be started in each house or section, 500 being removed at seven weeks of age for the poussin market.

At this age poussin should average about 2-2¼ lb. live weight or 1¾-2 lb. plucked, which is equivalent to about 22-24 oz. eviscerated (oven-ready) weight.

Battery or tier brooders and carry-on cages are used extensively for poussin production, a number of large specialist plants having been established in recent years.

In some plants the run sections of tier brooders are extended by removing partitions as the chicks grow; in others the birds are reared in the brooders for the first 3½ weeks or thereabouts, when they are transferred to carry-on cages in "cooler" rooms.

is most commonly in crumb form, perhaps followed by chick pellets

Poussin production has the advantage of a quick turnover, but profit margins are necessarily slender As in broiler production, a market should be found before embarking on a project of this kind

Large-bird Production. Producers catering for a market requiring birds over average broiler weight ($3\frac{1}{2}$–4 lb live weight), including capons, should endeavour to adopt intensive methods throughout

Chicks should be hatched at the appropriate time to attain the required weight when the market is ready for them It is uneconomic to feed them after this stage is reached

For example, cockerels of superior table strains well managed and given an efficient diet will reach at least 8 lb live weight when twenty weeks old

Birds of this age are ready for the capon market If retained longer they will consume a large amount of food without making appreciable weight gain, certainly any increase in weight will be obtained at high cost

This is mentioned because there is a tendency to hatch chicks unnecessarily early for the large-bird market Chicks intended for the Christmas trade may be hatched in May or June, whereas correctly fed and managed July hatched birds will fulfil market needs

Special broiler diets should not be fed to chicks reared for this market These diets will produce more rapid growth than the conventional chick diet during the early stages, but this ad vantage will be lost when large birds are marketed

A standard chick diet should be fed for the first 8 12 weeks, followed by a growers' mash with or without grain

Supplementary feeds of wet mash may be given in the later stages, or during the last three or four weeks before killing a fattening mash may be given as a wet mash two or three times daily

Appetites must be watched Should they tend to flag, some changes in feeding may be necessary to restore them If wet mash is fed a meal may be missed occasionally or soaked grain may replace mash from time to time Soaked grain is often very helpful when appetites for mash are getting a little jaded

Trough Feeding and Cramming. Trough feeding implies confining the birds to fattening crates either in a shed or yard surrounded by a high fence.

In normal circumstances such a method of feeding is not recommended unless the birds are to be finished by a course of cramming.

Trough feeding and cramming is the standard method of producing prime "Surreys", but today few cater for this trade.

If the work is undertaken, after ten days trough feeding a large majority of the birds will be sufficiently well finished to warrant the description of "Surrey"; whether or not they should be crammed is a matter for the producer's discretion.

Fattening-crates. Fattening-crates for indoor use have slatted tops, and those for outdoor use a sloping roof. The fronts are constructed of wooden slats about 2 in. apart, the two central ones sliding up and down for the removal of the birds. The floors are slatted.

The crates are usually 7 ft. long, 20 in. from front to back, 18 in. high in front, and 14 in. high at the back. They are divided into three sections each holding five or six birds. A V-shaped feeding-trough supported by two lengths of string is fitted along the front at about the level of the slatted floor.

The crates are arranged in rows sufficiently far apart to ensure comfortable working conditions. When the birds are first placed in the crates they are starved for 24 hrs. to sharpen their appetites, then they are given two meals of wet mash per day. The food has normally consisted of Sussex ground oats mixed with skimmed milk to the consistency of thick cream. No drinking-water is supplied.

If trough-feeding is to be successful it must not be carried out in a mechanical manner. Considerable skill is required to keep the birds feeding well. They will quickly lose their appetites if overfed, and once appetites are lost trough-feeding will be a complete failure.

The birds should be given two or three helpings at each meal, the quantity of food depending on their appetites. When the feeder makes his second or third journey along the crates, he should give more food to the birds that have cleared up the previous helping by taking the food left by those that have had all they require.

Appetites must be closely watched The moment a bird ceases to feed well it should be marketed or crammed If left in the crates it will lose condition.

The increase in weight during trough-feeding is very variable Much depends on the condition of the birds when brought in A lean bird will put on much more weight than one in good condition. The quality of the flesh, however, is improved

After ten days' trough-feeding pullets may be expected to show an increase of about 6 oz and cockerels about 10 oz, or an average for mixed sexes of about 8 oz The increase in weight varies considerably in different individuals and in different lots The above figures would not be reached if the birds have had a rich and abundant diet, and are in fact semi-fattened before they are placed in the crates

Cramming Cramming follows trough-feeding, and it is usual to continue each process for ten days

The cramming-machine stands on a tripod It consists of a food-container fitted with plunger operated by a pedal When the latter is pressed, food is forced through a rubber tube which the crammer inserts in the bird's throat, the end of the tube entering the crop

The crammer holds the bird against his body with one hand on the crop The head is grasped with the other hand and the beak opened with the fingers The head is then drawn on to the nozzle of the machine, the pedal gently depressed and as soon as sufficient food has been forced into the crop, pressure on the pedal is released, the nozzle withdrawn and the bird returned to the crate.

An experienced man works with remarkable speed, dealing with about 150 birds per hour, including the time taken in moving the machine

Cramming is done twice a day, first thing in the morning and again in the late afternoon The ration normally consists of Sussex ground oats mixed to a creamy consistency with skimmed milk or skimmed-milk powder mixed with water It is usual to add mutton-fat at the rate of 5 or 6 per cent of the weight of ground oats

The food should be prepared over-night It should be mixed in tubs, the milk-powder being first thoroughly mixed with

water, all lumps being broken up. The mutton-fat should be heated, and when quite hot the liquid fat should be stirred in.

The cramming-machine must be kept clean. It should be rinsed between meals, and the rubber tube flushed and sterilized with boiling water.

By cramming for ten days pullets may be expected to increase

Photo] [illegible]

FIG. 157—A CRAMMER AT WORK

THE BROILER SYSTEM

The so-called broiler system of table poultry production has been applied on an ever-increasing scale in recent years, some producers or groups of producers having an output of many thousand birds per week.

Practised for many years in the United States, the system was first applied in this country by Geoffrey Sykes in Wiltshire in 1953.

Others quickly followed his example. In the course of a few years broiler production has become a great specialist section of the poultry industry, with an estimated output equivalent to about 100 million birds per annum by 1960.

Output continues to rise rapidly, so much so that some forecast an annual production in the region of 400 million birds in 1965.

Broiler production has not only become a major industry, its development has created an ancillary industry concerned with broiler processing and marketing.

Large-scale processing plants equipped with machinery by which the birds are killed, plucked and eviscerated on conveyor-line principles have been erected, some with a weekly thoughput exceeding 100,000 birds.

The name broiler is merely a trade term to denote good-quality birds of about 3½ lb. live weight, mass produced and marketed at about ten weeks of age. The term indicates both the type of bird and the method of production. It is not intended for use in consumer circles, where it is liable to be confused with boiler. Among consumers the broiler is known by the familiar name chicken.

Essential features of the broiler system are that rearing is undertaken in large groups, usually comprising 2,500 chicks or more per group.

Units of 5,000 chicks are, however, usually regarded as minimum for most economic production, i.e., broiler houses are not usually of less than this capacity, and there may be many such houses on individual holdings.

It is not, of course, necessary to operate on so large a scale. Many producers work with smaller units, but in common with the larger producers they co-operate with other producers or

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Photo: Modern Poultry Keeping

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Thus there is a break of two to three weeks between each batch for cleaning and disinfection. This is essential to prevent the build-up of infection that occurs when houses are continually occupied, as would be the case if chicks of different age groups were reared in the same houses.

Photo Poultry Farmer and Packer

FIG 158—BROILER HOUSE

A type of broiler house popular with large scale producers This house, built with Lignacite blocks on concrete footings, has an asbestos cement roof lined with fibreboard It is designed to rear 5,000 chicks to twelve weeks old

For 5,000 birds, a popular unit with large producers, a broiler house about 142 ft. × 37 ft with central food store is commonly used. Each half of the house provides a floor area of about 2,500 sq. ft. on which the same number of chicks are

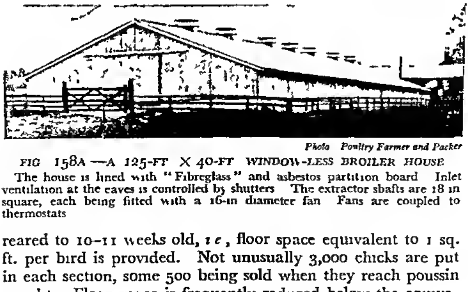


Photo Poultry Farmer and Packer

FIG 158A—A 125-FT × 40-FT WINDOW-LESS BROILER HOUSE

The house is lined with "Fibreglass" and asbestos partition board Inlet ventilation at the eaves is controlled by shutters The extractor shafts are 18 in square, each being fitted with a 16-in diameter fan Fans are coupled to thermostats

reared to 10–11 weeks old, *i e*, floor space equivalent to 1 sq. ft. per bird is provided. Not unusually 3,000 chicks are put in each section, some 500 being sold when they reach poussin weight. Floor space is frequently reduced below the equivalent of 1 sq. ft. per bird even when the whole of the crop is reared

to seventy days of age. Some producers stock their houses on the basis of about ¾ sq. ft. per bird.

Broiler houses may be built of the usual variety of materials. Houses of wood or of asbestos-cement sheets should be insulated, as should the roof of all buildings except those with an upper storey. Many houses are built with brick, hollow concrete or Lignacite blocks supported on concrete footings with damp course. Roofs may be of wood, aluminium or asbestos

Many broiler houses have earth floors, but concrete is preferable in the interests of hygiene.

Wood floors are not recommended except in multi-storey buildings. The latter are usually adapted farm buildings.

The pattern of artificial lighting varies widely on different plants, both with regard to duration and intensity.

A minimum of 14 hours feeding time is necessary, and when rearing in large groups dim lighting should be provided when normal lighting is turned off to prevent panic resulting in the chicks piling up, with consequent heavy losses.

To obviate the risk of panic, should the chicks be frightened when in darkness due to power failure some producers provide about 30 minutes darkness every 24 hours. This they claim accustoms the chicks to being in the dark, but it complicates the lighting schedule.

For normal (bright) lighting, five 40 or 60-watt lamps about 6 ft. from the litter and placed to ensure uniform distribution of light are adequate for each 1,000 sq. ft. of floor area. For dim lighting two 25-watt lamps are sufficient.

Some producers use all-night bright lighting; others provide only sufficient dim lighting to enable the birds to feed and find their way about the house. For continuous dim lighting four 15-watt lamps per 1,000 sq. ft. of floor area are commonly employed, although on numerous plants even less light is provided.

Chicks reared under dim lighting are usually docile and, of course, the risk of cannibalism is much reduced. Continuous dim lighting is now widely practised, and the use of red light as a precaution against cannibalism is common. Chicks are started under white light, red lamps replacing the white when the chicks are about seven to ten days old.

Fluorescent lighting is employed on many plants. Fluorescent tubes may be covered with red plastic shades if red lighting is desired or, of course, red tubes may be installed.

Some broiler growers have adopted an intermittent bright and dim lighting system.

Under such a system the birds may have half an hour of bright light followed by 1½ hours dim lighting throughout the day and night. There are many variations of this routine,

They follow the same general plan as hovers used for rearing pullets, but are much larger—usually having a capacity of 500–1,000 chicks

Gas-heated brooders may be operated from a main supply or cylinders "Propane" gas is now used extensively, some of the larger plants having the gas delivered in bulk, *i e*, the cylinders are refilled on the farm

Electric brooders of diverse types are favoured by some producers They are large-capacity units, some being thermostatically controlled Infra-red heaters are usually mounted on brackets in groups of four or in multiple units under canopies as explained in Chapter Twelve.

Silica-sheathed strip-type infra-red units are also popular, the units being suspended in file to provide a heated area adequate for the number of chicks

Heat-storage electric brooders have found their place in broiler production as well as oil-burning brooders suitable for rearing chicks in large groups

All the above types of brooders are found on broiler plants, choice is largely a matter of the personal preference of the producer.

Broiler houses have either continuous channel iron drinking troughs running along one or both sides of the house or portable drinkers with ball-trap control In the former water flows continuously The channel need not be more than 2 in wide at the top, the depth of water should be ½ in The height of the trough is adjustable

While the chicks are confined close to the brooders, drinking water is usually supplied in jam-jar drinkers or small galvanized conical drinkers of 1 gal capacity Eight drinkers should be provided per 1,000 chicks

After the initial brooding period chicks have access to wall or portable drinkers The latter are most widely used They are connected to the main supply by rubber or plastic tubing Troughs are fitted with ball tap control The top of the trough should be kept at about the same level as the chick's back Three 6 ft troughs or the equivalent should be provided per 1,000 chicks They should not be more than 15 ft apart

For the first few days food is usually fed on Keyes' egg trays or the lids of day old chick boxes Thereafter either a number

cut straw is cheaper. Wood shavings are usually sold in bags containing about 28 lb., *i.e.*, 80 bags per ton. About $1\frac{1}{4}$ tons will cover 1,000 sq. ft. floor area to a depth of about 6 in. About 1 ton of cut straw will cover this area to about the same depth.

On many broiler plants it is customary to build up the litter to a depth of about 6 in. When the chicks are sold, caked litter that may be present around drinkers and feeders is removed and the remainder heaped up and heated as described in Chapter 3.

While the litter is being treated the house is brushed down and sprayed with disinfectant or sterilized with a steam jenny. Aerosols to disperse disinfectants as a fine mist are now widely employed.

These processes are usually completed in the course of about a fortnight, when the litter is re-spread and lightly covered with new litter, except under the brooders, where the old litter may be completely replaced. It is doubtful, however, whether partial replacement of the litter serves a useful purpose. It will not prevent outbreaks of disease due to organisms in old litter, although it may postpone them.

Although this method of preventing the build-up of infection has proved satisfactory on many farms, it will be realized that the longer old litter is used, the greater the risk of an outbreak of disease. It is impossible to effect complete disinfection while litter used for previous batches of chicks remains in the house.

It is significant that most American broiler producers have abandoned the re-use of litter. They use new litter for each lot of chicks, having found from experience that old litter can be a potent source of danger to the health of the stock.

The practice of leaving broiler houses unoccupied for about fourteen days before putting in a consignment of baby chicks is frequently advised as a means of breaking the cycle of infection. If the houses are thoroughly disinfected a rest period is unnecessary, although it is doubtful whether it is possible to prepare them for the reception of chicks in a shorter period than fourteen days, whether or not litter is re-used.

Feeding. Special ready-mixed broiler rations are now fed almost exclusively. Few producers work out formulas and compound diets at home. They rely on the compounder to provide the most efficient rations, some of the larger producers testing one proprietary diet against another.

Without exception, *ad lib.* feeding is practised. Some producers favour dry-mash feeding, others crumbs throughout or crumbs for the first six to eight weeks, followed by broiler growers' pellets. Dry mash should not be of fine texture. A coarse mash is more palatable, and results in more efficient feed conversion.

Crumbs and/or pellets are fed extensively to-day because they give more efficient food conversion than a diet of the same composition in mash form.

Broiler diets are balanced for calcium content, therefore calcium grit should not be provided.

Granite or flint grit may be given in limited amounts, but few consider this worthwhile. Experiments show that in broiler production, where grain is not fed, the provision of insoluble grit is not warranted.

There is considerable difference of opinion in relation to the number of diets that should be fed from day-old to marketing time.

Some producers use the same diet throughout, perhaps changing from crumbs to pellets when the chicks are six weeks old.

Others feed a broiler starter diet from day-old to six weeks, followed by a broiler finisher diet; yet others feed a pre-starter diet for the first two weeks, followed by starter and finisher diets.

	Starting ration (0 6 weeks)	Finishing ration
Ground yellow corn, lb /ton	1,237 3	1,377 3
Menhaden fish meal, 60% protein, lb /ton	125	100
Poultry by products meal, 56% protein, lb /ton	150	75
Soyabean meal, hulled, 50% protein, lb /ton	270	255
Corn gluten meal, lb /ton	100	75
Dehydrated alfalfa meal, 17% protein (100,000 I U vitamin A/lb), lb /ton	30	30
Distillers solubles (corn), lb /ton	30	30
Butyl fermentation sol (By 100) lb /ton	20	20
Limestone, lb /ton	22	22
Dicalcium phosphate, lb /ton	6	6
Salt, iodized, lb /ton	6	6
Trace mineral mix, lb /ton	2	2
DL-methionine, lb /ton	0 2	0 2
Choline chloride, lb /ton	0 5	0 5
Diphenyl *para* phenylenediamine (D P P D), lb / ton	0 25	0 25
Nicarbazin, lb /ton	0 25	0 25
Arsanilic acid, gm /ton	90	90
Riboflavin, gm /ton	3	3
Calcium pantothenate, gm /ton	5	5
Niacin gm /ton	25	25
Vitamin A, million I U /ton	4	4
Vitamin D3 million I C U /ton	0 8	0 8
Vitamin B12, mgm /ton	3	3
Procaine penicillin, gm /ton	25	25
Streptomycin gm /ton	75	75
Menadione sodium bisulphate, gm /ton	1	1
Total, lb	2,000	2,000

A simplified ration based on the recommendations of Combs (University of Maryland) has been used successfully at the National Institute of Poultry Husbandry by Cook (1956)

The formula is as follows

	Parts by weight
Maize meal	33
Steamed bone flour	1
Fish meal (65%)	7
Soyabean meal	20
Dried yeast	2
Limestone flour	1 5
Manganized salt	0 5
Ground wheat	33
Penicillin	1
Premix Vitamins A, D3 B2	1
	100 0

Thus the average live weight of birds having the American-type mash was about the same at ten weeks of age as that of birds having the English type of chick-starter mash was at twelve weeks.

Since the above work was undertaken, broiler diets available in this country have been improved. They are now as efficient as American diets.

Recent examples of American broiler diets are given below.

Examples of Broiler Starter Rations (New York State College of Agriculture, 1950)

Examples of Broiler Finisher Rations (New York State College of Agriculture, 1959)

Ingredients	Lb /ton *	Lb /ton *	Lb /ton *
Ground yellow corn	1,369	1,184	1,208
Soya bean oil meal, 50%	220	300	400
Corn gluten meal	100	100	—
Fish meal	50	50	—
Fish solubles	—	—	20
Meat and bone scrap, 50%	100	100	100
Stabilized fat	—	100	100
Distillers' dried solubles	40	40	40
Dried whey or whey product	40	40	40
Alfalfa meal	50	50	50
Dicalcium phosphate	5	10	15
Limestone	20	20	20
Salt, iodized	5	5	5
Manganese sulphate, 70%	0 4	0 4	0 4
Zinc carbonate	0 1	0 1	0 1
DL-Methionine	—	0 1	0 8
Vitamin A (stabilized), U S P units	2 000 000	2 000 000	2 000 000
Vitamin D3 supplement (I C units)	680 000	680 000	680 000
Vitamin, antibiotic, anti-oxidant supplement †	0 6	0 6	0 6
Calculated Composition			
Protein, %	19 2	20 4	19 8
Calcium, %	1 23	1 30	1 24
Phosphorus, total %	0 71	0 76	0 75
Phosphorus, available, %	0 48	0 53	0 52
Vitamin A, units/lb	5 000	4 800	4,700
Vitamin D, units/lb	340	340	340
Riboflavin, mg /lb	1 8	1 8	1 9
Niacin, mg /lb	16	16	15
Pantothenic acid, mg /lb	6 3	6 4	6 5
Vitamin B12, µg /lb	4	4	4
Metabolizable energy, Cal /lb	1,410	1,470	1 480
Productive energy, Cal /lb	950	1,020	1,010
M E /P	74	72	74
P E /P	50	50	51
Methionine and cystine, % of protein	3 55	3 50	3 50

* 2 000 lb

† Contains 1 gm riboflavin, 8 gm niacin, 5 gm calcium pantothenate, 4 mg vitamin B12, 3–5 gm antibiotic and 0 25 lb Santoquin or B H T

The above formulas indicate the complexity of modern broiler diets To-day there is a marked trend to the increasing use of synthetic additives. The highly efficient diets now employed in broiler production cannot be readily simplified

De-beaking. The broiler system may induce feather plucking and cannibalism on account of the large number of chicks reared in one group Outbreaks are especially liable to occur if the birds are kept in brightly lit houses Other contributory

factors are inadequate ventilation, crowding, insufficient feeding space and dietary deficiencies.

As dry mash provides more occupation for the birds than crumbs or pellets, the former system of feeding is practised on many plants. Despite this, feather plucking may occur.

As a precautionary measure the chicks may be de-beaked at day old. Electric de-beaking machines that remove part of the top beak and cauterize the raw surface are available.

Some producers de-beak the chicks only in the event of trouble arising; others de-beak as a matter of routine at the three-to-four-weeks-old stage.

De-beaking takes time, and if undertaken after the chicks are housed it causes considerable disturbance, which cannot be good for them or for the producer's packet.

Cannibalism will not occur if management is sound and the chicks are reared under red or dim light.

Loss of Appetite. There is a tendency for appetites to flag when the chicks are about seven to eight weeks old. This may arise from crowding, insufficient ventilation, overheating (in hot weather) and other factors, but even under the most favourable conditions it is sometimes difficult to keep the birds feeding well at this stage.

A change in feeding, *e.g.*, from mash to pellets, may put matters right, or pellets can be given as a supplementary feed over the mash.

High-level feeding of antibiotics (for about one week) will often restore jaded appetites, many producers keeping a supply on hand for immediate use in these circumstances.

Catching Birds. A catching cage may be used when collecting the birds for killing. A wire cage about 10 ft. × 6 ft. will be found a convenient size. It can consist of wire-covered frames held together with hook-and-eye fasteners. Alternatively, the birds can be driven into a small enclosure of wire netting.

Catching should be done as quietly as possible. The catching cage or enclosure should not be overcrowded. Less disturbance will be caused if the birds are caught in very dim light. A catching cage is then unnecessary. They are easily picked up.

TABLE-POULTRY PROCESSING

Killing. Birds should be starved prior to killing, but they should have drinking-water

Starvation ensures an empty crop and reduces the amount of food in the intestines Unless the birds are starved, the flesh of the abdomen will turn green after killing, owing to the decomposition of food in the lower part of the digestive tract

Discoloration will also occur if the birds are packed before being thoroughly cooled So-called "green-packs" are a cause of serious loss

For years it was customary to starve birds for twenty to twenty-four hours before killing Recent investigation, however, has shown that much shorter periods are adequate For birds about 4 lb live weight twelve hours are sufficient, a rather shorter period is required for smaller birds and a rather longer one for larger birds

When rapid cooling can be effected by chill rooms, refrigeration shelves or by immersion in cold, preferably iced water, four to six hours starvation is sufficient for all mash fed birds, about ten hours for those having grain

Protracted starving will cause unnecessary loss of weight, especially among poussins and other classes of small chicken including broilers The interval between catching the birds and killing at the processing station will provide sufficient starvation

The most common method of killing, except in poultry processing stations, is by dislocation of the neck It is a clean, rapid method, and since the birds are usually sold by weight, the producer may have the benefit of a few extra ounces in the weight of the blood compared with birds killed by bleeding

Many buyers, however, now pay a little more for bled birds In central markets they usually realize *1d–2d* lb more than unbled birds

To kill by dislocation of the neck proceed as follows Grasp the bird by the shanks with the left hand and hold firmly close to the body near the hips Some people hold the wing tips with the shanks to prevent fluttering Open the first two fingers of the right hand, and in the fork so formed hold the bird's head, immediately behind the skull, with the thumb

under the lower beak. *Fully extend the neck by moving the right hand downwards, then with a strong downward thrust, and at the same time turning the bird's head backwards over the neck, the latter is dislocated immediately behind the skull. The blood will drain into the cavity so formed.*

Photo: Modern Poultry Keeping

FIG. 159A.—KILLING

Killing by dislocation of the neck. Grasp the legs in the left hand held near the waist and hold the head immediately behind the skull between the first two *fingers of the right hand.* Then force right hand downwards and at the same time turn the bird's head over as shown. This will dislocate the neck.

The actual pressure required to effect dislocation is a matter for discretion. Obviously more is required to kill a mature cockerel than a young chicken. If too much pressure is employed the head may be pulled off or at least the skin broken, resulting in loss of blood, which makes plucking a messy business.

Killing by bleeding is now extensively practised in this country, mainly by packing-stations, but unless a premium is paid for bled carcases the producer is not justified in using this method of killing.

Bleeding is unnecessary for birds that are to be kept in commercial cold stores (13–17° F.) for a few weeks, but for pro-

longed storage at $0° \pm 5°$ F, *i.e.*, deep frozen, bleeding is essential, otherwise blood liquefies and runs back from the point of dislocation of the neck into the area around the crop, causing discoloration

Photo Cope and Cope Ltd Reading

FIG 160.—A SET OF CONE SHAPED DRAINERS USED IN KILLING TABLE POULTRY BY BLEEDING

Birds that are to be eviscerated need not be bled, since the blood clot is removed during dressing

The procedure adopted when bleeding differs in detail The birds may be stunned by a sharp blow on the back of the head with a heavy stick, put head downwards into cone-shaped drainers and bled by cutting the jugular vein behind the ear (external cut) or by forcing the killing knife through the top of the mouth behind and to the left of the groove, severing the blood vessels at this point The cut should

not be made in front of the point indicated, because the veins soon enter the skull. This is the "internal-cut" method.

A second cut may be made by forcing the point of the knife through the groove in the roof of the mouth into the brain. When properly done this will cause loosening of the feathers, and thus make plucking easier.

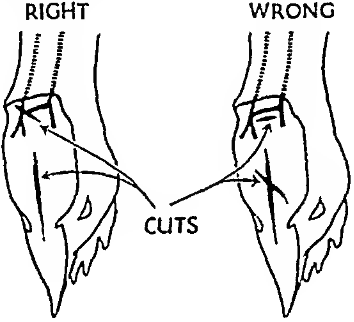


FIG. 161.—KILLING BY STICKING
(Internal cut)

Some prefer to stun the birds after they are placed in the draining cones. The cones prevent flapping, and thus reduce the incidence of broken wings due to brittleness of the bone that occurs in some very-rapid-growing chicks despite their having a balanced diet.

Birds may be killed by bleeding when suspended head downwards from shackles. In processing stations the birds are stunned, suspended from shackles on a conveyor track and cut, blood draining from the birds as it passes over a bleeding trough on its way to the plucker.

Latest method is stunning by electricity. The birds are suspended head downwards from shackles on the conveyor

track and are then stunned electrically while they are carried towards the killer.

This is the best method of stunning, since its effect is positive, it limits reflex action and assists bleeding and plucking. Little effort is required by the operator, who merely touches the bird's comb as it passes along the conveyor line.

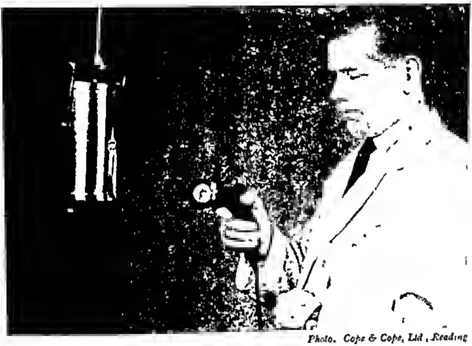


Photo. Cope & Cope, Ltd., Reading

FIG. 161A.—A LOW-VOLTAGE STUNNER OF THE TONO TYPE

The tongs are fitted with wire brushes which make contact with the comb and wattles. For chickens the stunner operates at about 90 volts. Stunning time is approximately $\frac{1}{2}$–$\frac{3}{4}$ second

Electric stunners using the standard A.C. mains 200/250 voltage are not entirely without some risk to the operator, who may experience a shock unless every care is taken to avoid this.

In order to obviate this risk, and at the same time to ensure efficient stunning, a low-voltage stunner has been designed. This operates at 90 volts, the normal working voltage of the instrument which has a peak output of 125 volts.

Even when a low-voltage stunner is used, however, the operator is advised to wear a rubber glove, at least on the hand holding the bird while stunning.

The low-voltage stunner is in the form of tongs with wire brushes top and bottom which make contact with the comb and wattle.

Whichever method of killing is employed—bleeding or dislocation—it is essential that the blood should drain from the

[illegible]

FIG. 161B.—STUNNING BY ELECTRICITY AT A PROCESSING STATION

[illegible]

body. Improperly bled birds have dark flesh and an unattractive appearance, due to blood in the feather follicles.

Special instruments for killing by bleeding are now available.

Birds killed by this method lose from 40–50 per cent of the total blood in the body or about 4–5 per cent of their weight.

[illegible]. Plucking should begin immediately after killing, because the work is much easier when the body is warm. For practical purposes [illegible]

one operation, since the killer usually plucks the birds as he kills them. He does not kill a number and then proceed to pluck them.

The plucker should sit on a low stool with a sack over his knees and a box between his legs to catch the feathers. The bird is held by the legs in the left hand with the head hanging between the knees. This is the conventional method practised in this country, but if the beginner is trained to pluck birds suspended from shackles, both hands are free to do the work.

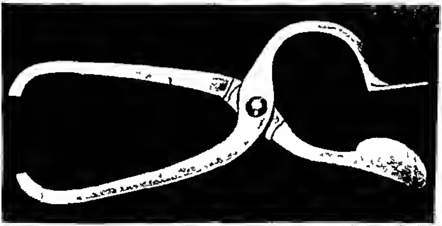


Photo: Cope and Cope, Ltd., Reading

FIG. 162.—KILLING PLIERS USED FOR KILLING BY BLEEDING

If used in the correct position in the bird's head complete bleeding and easy plucking result.

Plucking should begin on the back. A few feathers should be held between finger and thumb and with a sharp downward pull plucked from the body.

Having removed the feathers from the back and neck to within about two or three inches of the head, one should turn the bird over and pluck the breast, finishing with the legs, wings and tail. The quill-feathers should be plucked singly.

Stub feathers are removed singly with a short, blunt knife, the blade being placed under the feather, the latter being held against it by pressure with the thumb, the index-finger supporting the knife-blade. A sharp pull will remove the stub.

An expert works very rapidly. He may kill and pluck from fifteen to twenty birds per hour and stub ten to twelve birds per hour, but, taking the average working day, ten birds per hour in each case is a reasonable output.

Photo: Poultry Farmer and Packer

FIG. 163.—AT SOME PROCESSING STATIONS ELECTRIC STUNNERS ARE MOUNTED AT BIRD'S HEAD HEIGHT BELOW THE CONVEYOR TRACK

As the birds pass in front of the stunner the wattles or comb are pressed against it

Machine Plucking. Plucking-machines are of comparatively recent introduction. Among earlier types some were unsatisfactory, but others have proved their value. They are used largely by the bigger producers, and of course by poultry packing stations.

There are two types of plucking machine—dry pluckers and wet pluckers. With the former, after removing the large quill-feathers, the bird is held against the machine which draws the feathers into rapidly revolving steel plates which pluck them.

FIG 164 —PLUCKING

Plucking should begin immediately Place bird on sack across knees and commence plucking the back Then turn the bird over and pluck the breast, legs, abdomen and finally the wings

Photos Modern Poultry Keeping

FIG 165 —STUBBING

Stubbing (removal of short feathers growing in) should be done with a short blunt knife Place blade under stub press latter to blade with thumb and remove stub with a sharp pull

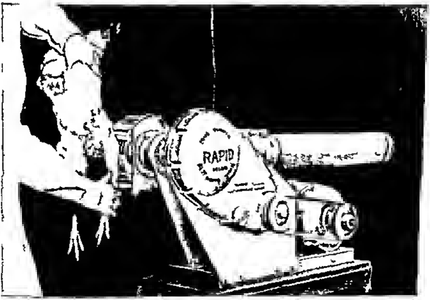


Photo Comb Pluckers Ltd

FIG 166—PLUCKING BY MACHINE

With this type of machine a competent man will soon be able to deal with about twenty birds per hour.

After plucking, the few small stub-feathers remaining on the birds are removed by hand or by a stubbing machine.

The wet-plucking machine consists of a revolving drum fitted with short lengths of rubber—so-called rubber fingers—which project from it. Some of these machines have rubber

Photo: Poultry Farmer and Packer

FIG. 167.—A RUBBER FINGER PLUCKER WITH FLAIL ATTACHMENT

This type of machine is widely used for small-scale processing.

flail attachments fitted to a revolving drum above and a little behind the rubber finger drums. The combined action of fingers and flails speeds up and ensures more complete plucking.

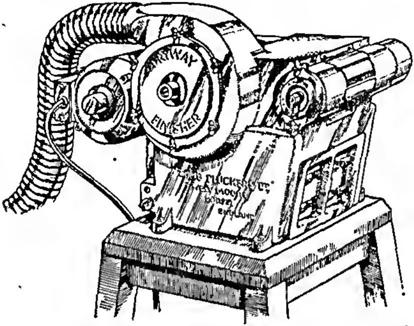
After semi-scalding (see page 531) the birds are held by the legs with the body against the revolving drum. By turning the birds over they are plucked in less than one minute. Quill feathers are usually removed by hand after machine plucking.

Actual output is usually limited by the human element. In practice, processing is a matter of team work, but no team can maintain throughout the day the output it could attain over a short test period. In addition, work is subject to inter-

ruption due to lack of continuity in supplies and other factors.

The modern plucking machine, like the modern egg grader, never operates continuously up to its maximum capacity.

Assuming the smaller type of rubber-finger plucker is operating with a team of four, of whom one is plucking, daily output of finished birds may be expected to be in the region of 450. This estimate provides for killing, dipping, hand



Comb Pluckers, Ltd

FIG. 168.—A STUBBING MACHINE FOR FINISHING THE BIRDS AFTER DRY PLUCKING

stubbing, washing the feet, pressing the vent to remove fæcal matter and hanging the birds in racks. The time occupied in these essential tasks can make an appreciable difference in terms of daily throughput.

In modern processing stations machine plucking and machine stubbing following semi-scalding are carried out on the conveyor line. Very little handling of the birds is undertaken. Stations are as fully mechanized as possible.

Live birds are suspended from shackles on the track, they are stunned, and bled as they move towards the first plucking machine, the " rougher ", with horizontally opposed plucking

drums with rubber flails They remain on the track to pass through a neck plucker, followed by the finishing pluckers but their position is reversed on their way round the conveyor line, *i e*, they are suspended by the head

Any stub feathers remaining are removed by hand at final inspection

In one model of the rubber finger type the fingers are attached to a vertical shaft in a cone shaped container After semi scalding in batches of about twelve, in a mechanically operated dipper, the birds are passed along a stainless steel chute entering the plucking machine at the top

Birds comprising each batch go into the machine together They enter at the top

Plucked birds are ejected through a door near the bottom

When sufficiently hard, the wax should be peeled off while the bird is still hung up. On some plants the birds are sprayed with or dipped in cold water to accelerate hardening of the wax

It is usual to commence with the legs and to work downwards over the body, finishing at the neck.

Photo Esso Petroleum Co Ltd

FIG 169—WAX PLUCKING

After dropping in heated wax the bird is suspended from shackles and the surplus wax drips off

The wax should not be allowed to become too hard, or it will be difficult to remove and may tear the skin If properly carried out the appearance of the birds is in no way impaired; on the contrary, wax plucking gives them an attractive bloom.

On commercial plants the birds are suspended from shackles

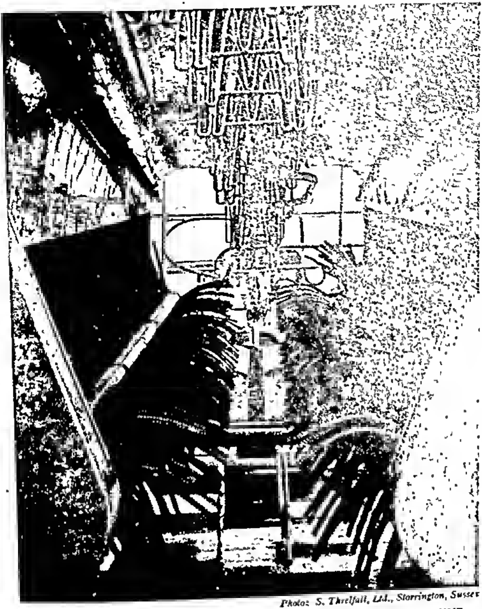


Photo: S. Threlfall, Ltd., Storrington, Sussex

FIG. 170A.—LOOKING THROUGH A MODERN PLUCKING MACHINE

Flails of the first plucker or rougher are seen in the foreground. A machine for the removal of the neck feathers stands between the rougher and second plucking machine or finisher. The birds are suspended from the shackles on the conveyor track seen above the plucking flails.

by a second plucking machine at the end of the plucking line.

Wet-plucking. There are two methods of wet-plucking, known as scalding and semi-scalding. The former consists

of dipping the birds for a few seconds in water at a temperature of 180–190° F. The birds should be held by legs and head as for wax-plucking. Scalding dissolves the fat and brings the yellow pigment (in birds showing it) to the surface. When cooled they look most unattractive. This method is more suitable for birds intended for immediate consumption

quality of the consignment, condition of the feathering and other factors. Correct timing for this process is important, as is also the interval between killing and dipping. The latter should not exceed sixty seconds. Work at the National Institute of Poultry Husbandry indicates that forty to fifty seconds between killing and dipping is optimum.

Photo Fatstock Marketing Corporation Ltd., London

FIG. 172.—POULTRY PROCESSING

A rotary dipping machine which operates on the principle of the dry-cleaning drum. The birds go into the drum in batches of about eight. They are then passed along a chute to a cyclomatic plucker seen in the background. This is a rubber-finger machine, the fingers being mounted on a vertical shaft. The birds are plucked in batches. They are not handled during the process.

Feathers plucked by the wet process when dried will fetch as much as those which are dry plucked.

Shaping, Tying and Cooling. After plucking and stubbing, the treatment of the birds will depend on market requirements, except of course that they should always be cooled as quickly as possible.

Shaping consists of placing the birds, breast downwards, in a trough made of two 6-in. boards set at an angle of 60° and arranged in the form of a shelf. The bird's abdomen is forced

against the rear board, the head and neck hanging over the front board. The birds are packed closely together, side by side, until the trough is full, when a board may be placed over their backs and weighted down with bricks or stones. In many cases although shaping troughs are used, pressing is not practised. In a few hours the birds will be cool and well shaped.

Photo Poultry Farmer and Packer

FIG 174 — POULTRY PROCESSING

Vacuum wrapping eviscerated table poultry in Cryovac bags When air is extracted the bags are sealed and dipped in hot water which causes the wrapping to shrink forming a skin tight covering

Photos Modern Poultry Keeping

FIG 175 — PLACE STRING OVER HOCKS—

—and with two short pieces tied to each of the centre toes pull shanks well down to side of breast take strings over back and tie Take two ends of string over hocks in left and right hands passing that in left over right of parson's nose and that in right over left and tie over tail

FIG 176 — FOLD WINGS OVER BACK

Fold wings over back by pressing them downwards and backwards

For processing so called fresh, *i e*, uneviscerated, table birds a chilling room should be regarded as essential

Immersion freezing is employed by some processing stations After evisceration and trussing the birds are individually wrapped in sealed polythene bags and are then immersed in a solution of calcium chloride

Since the birds float in such a solution, they are also sprayed with it by jets over the freezer tank and are finally immersed by a submerged conveyor belt or other means

Following freezing by this method, the birds are dipped in water to remove the calcium chloride solution from the wrappers and are then stored at low temperature

Usual practice in commercial processing is to chill the birds in chip ice after they leave the final plucking machine They are then examined and any remaining stub feathers removed They may be tied and removed to a cold store or eviscerated, wrapped in film and quick-frozen

Proper cooling and cold storage facilities are essential for efficient large-scale processing and marketing

Only producers with a very large output would be justified in installing the necessary plant The majority of producers now market both chickens and hens through a processing station

Table poultry processing has become a specialist section of the industry The work is highly technical, it calls for expert knowledge The average producer should confine himself to production and leave processing to others

If, however, the producer wishes to cater for farm gate sales or possibly to trade direct with local retailers he should build a cold room, he should also install a deep freeze conservator in which oven ready wrapped birds can be held for ten to fourteen days Birds can then be handed immediately to customers calling at the farm

Roping Roping refers to the removal of the intestines through the vent with the object of preventing discoloration of the flesh of the abdomen liable to occur in hot weather or when the birds are killed without being starved or packed before thoroughly cool *Roping is carried out as follows* —

> Squeeze the vent to remove any matter that may remain in the intestines With the bird on its back, insert the index finger into the vent, hook the finger round a loop of the

intestines and carefully withdraw until resistance indicates that they are removed. Squeeze with the fingers the first few inches of the small intestine—the last part to be withdrawn from the vent—to remove any matter that may remain. Cut the gut a few inches from the vent, tie with string and return this short upper part by pushing it through the vent. Cut off the lower part of the large intestine close to the vent, tie with string and finally push it through the vent.

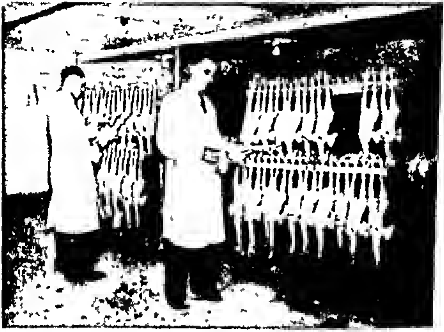


Photo: Poultry [illegible]

FIG. 177 GRADING BIRDS ON MOBILE RACKS

The birds are held on open racks in cold store prior to despatch from the packing station

Roping cannot be recommended. Although it will achieve its purpose, there are other and better methods of preventing greening.

Removal of the intestines in the manner described is unhygienic; waste matter is liable to get into the body cavity and so taint the flesh. Moreover, unless the processor keeps his hands clean, washing them frequently, there is a risk of infection, especially around the finger-nails.

Packing. Although many types of containers are used for packing poultry, cardboard or light wooden non-returnable boxes are most commonly employed today.

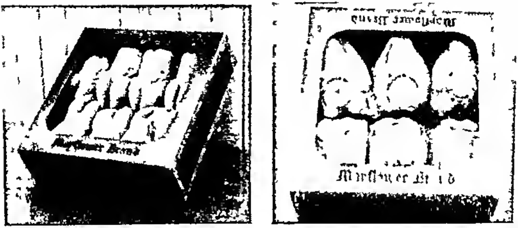


Photo Poultry Farmer and Packer

FIGS 178 AND 179 —CARDBOARD BOXES ARE NOW WIDELY USED FOR PACKING TABLE POULTRY

The box (*left*) contains clean plucked uneviscerated birds which are unwrapped The other box contains eviscerated (oven ready) birds wrapped in polythene and quick frozen

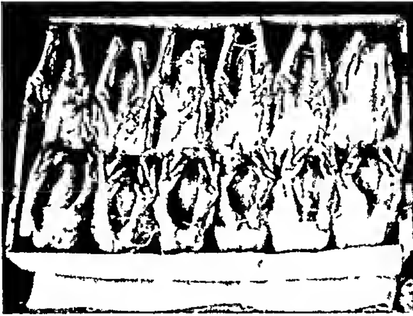


Photo Modern Poultry Keeping

FIG 180 —TABLE POULTRY PACKED IN A LIGHT WOODEN CASE

Plucked undrawn table poultry for the so-called fresh trade are commonly packed in dozens in paper lined light wooden cases of this type

Cardboard boxes are generally favoured for oven-ready birds, while for the "fresh" trade, i e, for clean plucked, undrawn birds light wooden boxes or cases are very popular. But some processors use the same type of container whether or not the birds are eviscerated

Boxes used for unwrapped poultry are usually lined with greaseproof paper, the birds being packed breast upwards Smaller birds are usually packed in dozens, but to avoid having a multiplicity of box sizes many use a "standard" box, in which six to twelve birds may be packed according to their weight

The Ministry of Agriculture give the following dimensions as a guide to sizes required for dressing poultry of different weights —

TABLE 41

Size of Boxes for 12 Birds

Weight per bird	Length, inches	Breadth, inches	Depth, inches	Approximate maximum capacity, lb
	(Internal dimensions)			
Under 1½ lb	21½	11¾	3½	20
1½–2	22½	14	3¾	24
2–3	24½	15¾	4	36
3–4	26	16¼	4½	48
4–5	27½	17¼	5¼	60
5–6	29½	18	6	72

Each box contains birds carefully graded by weight and quality, details of which are given on the label, which also bears the sender's name and address Thus the buyer knows at a glance the quality of the birds each box contains, and will usually accept them without inspection of the contents, provided, of course, that the sender is known to him Boxes whether of wood or cardboard should be fastened by means of a wire-tying machine

This method of packing is in accordance with modern requirements of the large wholesale markets, and it must be adopted by producers or processors if they are to compete successfully in the trade in which competition is extremely keen

Presentation is a factor of the greatest importance in marketing. Buyers want attractive packs containing birds of approximately the same weight and quality. They want to do business without having to grade a consignment of birds of different quality. Grading is not the buyer's job.

Allowance for Loss of Weight. When birds are killed and plucked an allowance must be made for loss of weight, because unless otherwise stated quotations are for plucked birds. The loss is about 8–10 per cent of the live weight.

TABLE 42

Percentage Loss of Weight in Dressing Poultry

	Average live weight (lb.).	Dressed weight (plucked), % of live weight	Eviscerated, % of live weight	Edible meat.		
				% of live weight.	% of dressed weight.	% of eviscerated weight
Broilers	2·0	91·7	72·4	48·5	52·9	65·5
Fryers	3·5	90·0	73·9	48·4	53·8	65·8
Light hens	4·4	91·2	67·2	49·0	53·7	72·7
Heavy hens	5·2	91·1	69·4	51·1	56·2	74·1
Roasters	6·8	90·2	74·6	54·7	60·7	73·7
Average	—	90·8	71·3	50·3	55·5	70·4

When killed by bleeding there is an additional loss of about 4–5 per cent of the live weight of the fowl.

In broiler production a difference of 12½ per cent between live weight and plucked (bled) weight is the usually accepted loss.

However, with all classes of poultry the difference between live weight on the farm and that returned by the processing station may be much greater, particularly if the journey to the station is long and the weather hot.

On dressing for the oven the loss of weight is equal to about 20 per cent of the weight when plucked (the oven weight including the giblets), or about 65 to 75 per cent of the live weight, depending on the condition of the bird. The fattened bird will show a proportionately lower loss of weight than the lean bird.

The amount of edible meat is lower than popularly supposed,

as will be seen from Table 42, showing data by Brown and Bean (1951)

Jewish Trade There is a keen demand for poultry for the Jewish festivals Producers who cater for this trade must supply birds in really good condition, and the birds must be sold alive for "kosher killing", or killing under the supervision of a rabbi

Drawing and Trussing Drawing and trussing is the work of the processor or poulterer It is not carried out by producers unless they have a private trade with consumers but all poultry men should know how to dress a bird for the oven

A sharp trussing knife, trussing needle, a ball of thin white string, some clean newspaper, a bucket, a bowl of water and a towel, together with sheets of greaseproof paper, complete the necessary equipment

In dressing a bird one may proceed as follows —

> First trim the wing tips, then remove the long hair by singeing This is done by holding the bird by the head in one hand and the legs in the other and passing the body over a methylated spirit stove or Bunsen burner
>
> Lay the bird breast downwards on the table and with the left hand pull up the skin at the base of the neck A little above the point where the neck enters the body, pierce the skin with the point of the knife and cut downwards towards the head This will expose the neck proper which should be removed by cutting through at the base
>
> The neck should then be raised, and the skin below it cut about *1 in* from the body, thus forming a flap of skin that will later close the neck opening
>
> Sever the neck behind the head at the point of dislocation and remove the skin from the neck, the latter being included in the giblets
>
> Turn the bird on its back and remove the crop Then insert the index finger as far as possible into the body and, working the finger round close to the body, loosen the lungs etc from the backbone and ribs Turn the bird round hold the parson's nose in the left hand and with the knife in the right hand make a horizontal cut between the parson's nose and the vent This will expose the intestines, and care should be taken not to cut them The index finger should be inserted through the opening and looped round the *intestines* close to the vent Hold the intestines away from the latter and cut out the vent with bowel attached Then insert the right hand grasp the gizzard and gently withdraw it, when, if the loosening

FIG 181 —SINGEING

Singe off the long hairs by holding the bird by legs and neck and turning over a methylated spirit flame or gas burner

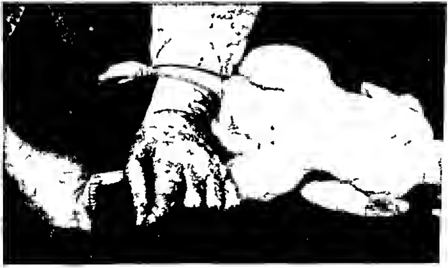


FIG 182 —REMOVING SINEWS

Cut skin round shank and break shank by pressing over the edge of a table

FIG 183.—REMOVING SINEWS
Hold the leg in the left hand and pull the foot with the right when the sinews will be withdrawn

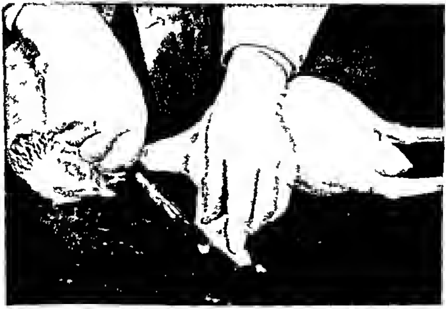


FIG 184.—TRIM THE WING POINTS

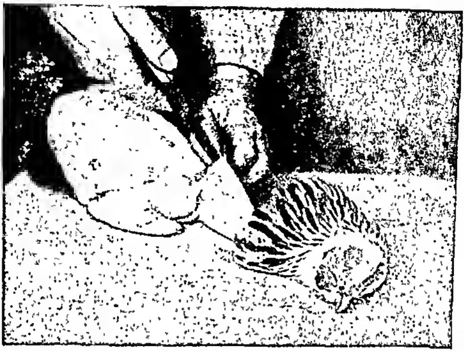


FIG. 185.—WITH THE BIRO ON ITS BREAST CUT THROUGH THE SKIN AT *THE BASE OF THE NECK*

FIG. 186.—REMOVE NECK BY CUTTING WELL INSIDE THE BODY
Cut through skin of neck to form a flap that will close neck opening. Sever neck behind the head.

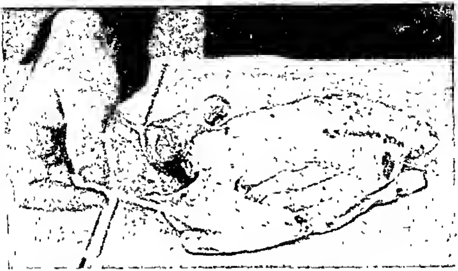


FIG. 187.—THE FLAP OF SKIN WILL CLOSE THE OPENING WHEN THE CROP HAS BEEN REMOVED

FIG. 188.—REMOVE CROP, THEN INSERT INDEX FINGER AS FAR AS POSSIBLE INTO THE BODY AND WORK ROUND LUNGS, ETC., LOOSENING THEM FROM THE CARCASE

FIG. 189.—OPEN ABDOMEN BY CUTTING BELOW THE TAIL

FIG. 190.—INSERT FINGERS, GRASP THE GIZZARD AND PULL GENTLY BUT FIRMLY WHEN, IF THE ORGANS HAVE BEEN PROPERLY LOOSENED, THEY WILL COME OUT WHOLE

The gizzard, liver and heart should be cut away from the other parts. The gall bladder should be removed from liver, taking care not to break it.

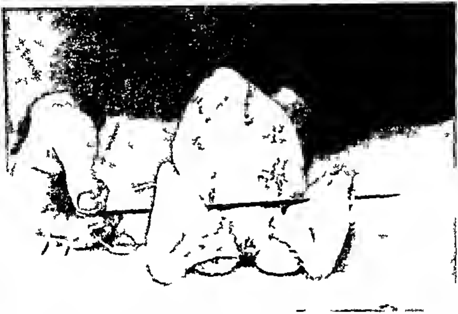


FIG 191 —THREAD TRUSSING NEEDLE WITH WHITE STRING, FOLD WINGS OVER BACK AND PASS NEEDLE THROUGH THEM AT THE POINTS SHOWN IN THE PHOTOGRAPH

FIG 192 —PASS THE NEEDLE THROUGH BOTH WINGS—

FIG 193 —PRESS THE LEGS DOWNWARDS PASS NEEDLE THROUGH BODY FROM THIGH TO THIGH—

FIG 194 —THEN BRING THE TWO ENDS OF THE STRING OVER THE BACK AND TIE MAKING SURE THAT THE FLAP OF SKIN IS COVERING THE NECK HOLE

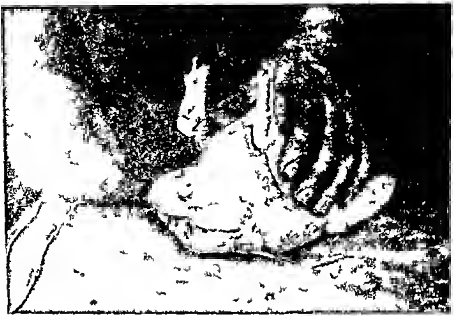


FIG 195—PASS NEEDLE THROUGH THE BACK AT THE POINT SHOWN—

FIG 196—OVER THE HOCKS AND UNDER THE END OF THE BREAST BONE AND TIE

of the organs already mentioned has been done properly, they should come out in one mass

The heart, gizzard and liver should be cut away and the gall-bladder removed, taking care not to break it

With young chickens, it is unnecessary to remove the sinews from the legs, but in older birds this should be done by cutting the skin round the shank immediately below the hock, breaking the leg bone and then gripping the foot and pulling strongly, when the sinews will be withdrawn with it Some prefer the following method Slit the skin of the shank to expose the sinews, insert a strong skewer under them, run the skewer up and down the shank to free them, turn it round

FIG 197—THE FINISHED PRODUCT, WITH THE GIBLETS—THE GIZZARD, NECK, HEART AND LIVER

to twist sinews over it and then withdraw sinews by holding the leg with the left hand and pulling the skewer strongly with the right The legs should be chopped off just below the hocks

The bird is now ready for trussing There are several methods of carrying out this work, and producers should adopt the one favoured in their district

Trussing on the following lines will ensure an attractive carcase —

Thread the needle with string, fold the flap of skin over the neck opening, and the wings over the back as shown in the illustration (Fig 191) Pass the needle through the wing

below the "elbow", over the bird's back and through the other wing in the corresponding position Then press down the leg as shown in Fig 193 Pass the needle through the leg, the body and through the leg on the opposite side and tie the two ends of the string (Fig 194)

With the bird still on its back, pass the needle through the skin under the pelvic bone (Fig 195), out under the other pelvic bone, then round the hock joint and through the skin at the tip of the breast-bone, over the other hock-joint and tie (Fig 196) The gizzard should be cut longitudinally and the lining peeled off Gizzard, neck, liver and heart are the giblets

Cold Storage. For short-period cold storage at temperatures of 14–17° F it is unnecessary to wrap the birds individually or to kill by bleeding Packed in paper-lined boxes the birds will keep well in this temperature range for several weeks, provided they are in good condition when placed in storage

The bulk of supplies passing through wholesale markets are packed in this way The birds are not eviscerated They are held in commercial cold stores at the above temperatures

Cold storage should be undertaken only if a remunerative price cannot be found for the fresh product Cold storage is not directly profitable, but in times of over supply it will relieve the market of surplus birds and thus assist in the stabilization of prices

Poultry should go into cold store without delay Consignments should not remain in the market and then be cold stored only if a good price cannot be obtained for them Many complaints of the poor quality of cold stored birds arise from loss of condition prior to storage

Commercial cold stores, although widely used, do not provide ideal conditions for the storage of poultry The deep-freeze process is far more satisfactory This involves quick freezing at −20° F for three or four hours, followed by storage at 0° F Poultry suitably packed will keep in perfect condition indefinitely if so treated

Individual wrapping is essential for the deep freeze process If not wrapped the flesh will be disfigured by so called freezer burn, due to dehydration of the skin

There is a variety of wrapping materials now available, *e g*, coated cellulose film which is impermeable to air (an

essential quality for the deep freezing process), "Pliofilm", plasticized rubber hydrochloride available in rolls for making up into bags, and Polythene

Cellulose film coated with nitro cellulose is a moisture-vapour proof transparent film, it does not shrink and therefore does not form a close fitting "skin" as in the case of some other wrapping materials It has heat sealing properties and can be made up into bags

"Pliofilm" can be used for the stretch method of wrapping On heating it stretches 100–150 per cent It is heated by drawing from a roll of the material a sufficient length to cover a frame of appropriate size beneath which an electric heater is fitted to a bracket

When the correct temperature is reached (about 84° F) the heater is swung to one side and the dressed carcase pushed down through the frame until there is sufficient film to cover the carcase The latter is then turned to twist the end of the film, which is finally heat sealed

"Pliofilm" has a greenish sheen and is somewhat opaque, but carcases so wrapped have an attractive appearance

Uneviscerated birds can be wrapped by the stretch method, but wing and leg points are liable to puncture the film

Polythene (polyethelene) is obtainable in tubular form in rolls It is thus readily made up into bags by sealing It is suitable for the deep freezing process It does not shrink to form a skin over the bird, but it is extremely strong, and if the wrapper is vacuumized it will provide a tight covering that will hold legs and wings firmly to the body

Polythene, cellulose film and other materials of this type are supplied in the form of ready made bags of various sizes They usually bear the processor's name and address and the brand name of his product Some are printed in attractive colours

Many millions of these bags are now used annually They may be sealed by metal rings or by sealing tape made for this specific purpose

Polyvinylidene chloride is a latex rubber product Cryovac is the best known of these materials It is suitable for wrapping for the fresh trade, for commercial storage or for deep freezing It is made up into bags of appropriate size The birds are

vacuum wrapped in the bags and are then dipped in water at about 190° F for four to five seconds This causes the wrapper to shrink by some 30 per cent, the result being that the bird is encased in a tight-fitting skin not easily punctured

The film has a brownish tint, but on shrinking it forms a transparent glossy covering that is most attractive

While wrapping eviscerated birds individually is essential, the wrapping need not be vacuumized for deep-freeze storage of normal duration

Vacuum wrapping has certain advantages in addition to its value in preventing freeze burn during protracted storage There is less risk of damage to the wrapper, and the appearance of birds so wrapped is enhanced

But this method of wrapping increases the cost of processing, and for this reason it is not commonly adopted by packers It is only justified for wrappings that are not skin tight

Some packers wrap both eviscerated and uneviscerated birds individually to increase their appeal to consumers, in addition, of course, there is a strong case for individual wrapping on hygienic grounds

Moreover, many retail poulterers have neither the time nor the facilities for preparing plucked birds for the oven They want oven-ready, wrapped birds that they can hand over the counter

The sale of eviscerated birds is increasing and will continue to do so as more and more poulterers install refrigerated display counters The poultry trade in this country is following the American pattern In the United States of America almost all birds are eviscerated

Poultry Preservation by Antibiotics. A method of preserving poultry for short periods—sufficient to prevent spoilage during the course of normal display in stores—consists of chilling dressed birds in ice slush containing a minute quantity of the antibiotic aureomycin chlortetracycline The process is known as "acronizing"

It is said that birds so treated keep about twice as long as untreated birds

Only trace amounts of antibiotic are used (10 p p m), and it disappears during cooking

Although this method of food preservation is approved in

the United States of America, the use of antibiotics for this purpose is not yet permitted in this country.

The Cut-up Trade. The sale of poultry joints has not been developed extensively in this country. It may one day become an important section of the trade.

Birds intended for cutting up must be well finished and carry a high proportion of flesh to bone.

Joints are cut and wrapped with the bone in them. Breast, leg and wing may be wrapped together or separately. The wrapper should be backed by a stout card.

Cutting up provides two wing joints with part of the breast meat, two top leg joints, two drumsticks, two breast joints, neck and giblets.

The proportionate weight of each part relative to the weight of the bird will vary with its condition and method of carving.

A well-finished bird of 4 lb. eviscerated weight will yield about 18–20 oz. breast meat, 10 oz. wings (with portion of breast), 7 oz. top leg and about 9 oz. drumsticks, or about 30, 16, 11 and 14 per cent respectively of the eviscerated weight. Back and giblets will be about 1 lb. or 25 per cent.

A chicken of 66 oz. plucked weight will yield about 30 oz. meat, 16 oz. bones, 18½ oz. waste and 1½ oz. liver.

Chapter Nineteen

Poultry-houses and Appliances

Houses and appliances—the "dead stock" of the farm—represent a considerable proportion of the capital invested in the enterprise, particularly when the farm is run on intensive lines

Much thought should be given to the selection of houses and appliances and to their construction, because initial mistakes are easily made and costly to rectify

On thousands of poultry-farms discarded equipment can be seen—equipment that appealed to the beginner, who, unfortunately, soon discovered that it was either totally inefficient or at least unsuitable for his purpose

Whether or not the poultry-man should construct his houses and sundry equipment required for his business is a matter on which it is impossible to give definite guidance It depends on circumstances

In estimating the cost of home-made houses, compared with those supplied by manufacturers, the saving is frequently more apparent than real

The farmer may disregard the value of his own labour, he may ignore the fact that while building houses he could be more profitably employed in attending to other work on the farm—and of course the home-made house may not be so well constructed as one that is factory built

The question is one that the poultry-man must answer himself If he has the ability, the time and the necessary facilities, he may perhaps decide to build his houses at home, but few fulfil these conditions when starting a farm

Whatever the decision, houses and all poultry farm equipment should be efficiently designed for their purpose and substantially constructed "Cheap" and inefficient equipment will prove a most costly investment in the long run, and may be responsible for the failure of the business

This may be regarded as an exaggeration of the importance of the subject—but it is not.. Good housing is essential to the success of the poultry-farm, for the best stock in the world will fail to give satisfactory returns without it. As in other phases of poultry-farming, moderation should be practised. Over-elaboration is as unnecessary as it is uneconomic. As a general rule it is wise to avoid houses and equipment having new features for which makers usually claim great advantages. More often than not they prove to be merely good selling points.

The beginner will be wise to adopt a conservative policy in the selection of his equipment. He should choose designs that have stood the test of time, and if purchasing ready-made plant he should do so from a firm of high repute.

Houses should be built to provide shelter for the birds, to ensure comfort and good health. They should also be labour-saving. These requirements are easily fulfilled, provided it is recognized that the birds are creatures of the open air and are well protected by Nature.

The house should give shelter from rain and wind and provide adequate floor space, roosting and nesting accommodation for its inmates. It should be so constructed that extreme changes in temperature over short periods are avoided. The lay-out and equipment of the house should reduce to a minimum the cost of attending to the birds.

Extreme temperatures have an adverse effect on growth and production. According to Davies (1951) experiments have shown that egg production dropped 25 per cent at 10° F.; combs froze at 6° F. and no eggs were laid at 0° F. Up to 60° F. a steady increase in food consumption with temperature was recorded while about 65° F. a reverse tendency set in.

For practical purposes temperatures ranging from about 50° F. to 70° F. may be regarded as ideal (55° F. is optimum for adult birds), but lower temperatures down to freezing point will not affect egg production provided adequate supplies of food and water are available. Artificial heating of houses for adult stock is not warranted, although its advantages in large-scale chick production are recognized.

When the temperature is above 80° F., particularly with high humidity, the birds become distressed and production is

Building Materials. Matchboards and weather-boards are most commonly employed in poultry-house construction, but galvanized iron, aluminium alloy, wood-wool blocks, Lignacite blocks, plywood, hardboard, asbestos cement sheets, breeze blocks, concrete and brick may be used wholly or in part.

Timber. The majority of houses, however, are built with timber commonly known as red or yellow deal. It is also known as Baltic or Northern Pine. The wood is durable, reasonably hard and easily worked.

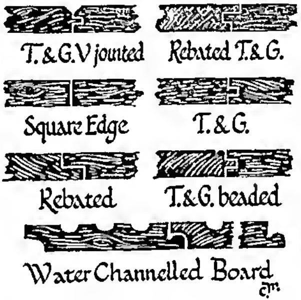


FIG. 198A.—TYPES OF BOARDING

White deal, also known as spruce, is largely used in the cheaper houses. It is light, not so durable as the red variety and is not recommended for exterior work, although quite useful for lining purposes and interior fittings.

Pressure-creosoted deal for poultry-house construction is used by certain manufacturers. Wood so treated will last a lifetime. It need not be creosoted again.

Cedar wood became very popular during the 1930s, when supplies were abundant and prices reasonable. Its usefulness for poultry-farm work is acknowledged by all having experience of it. The wood is reasonably hard and extremely durable, its

depressed. It may be said that high temperatures are far more injurious than low temperatures normally experienced in this country.

In low temperatures there may be difficulty in keeping the litter dry due to its inert condition and condensation of moisture, and there is loss of efficiency of feed conversion, because more food is required to maintain the body heat of the birds; nevertheless, insulation of well-built, adequately ventilated houses is not essential for adult birds, although fully justified in brooder-houses.

In view of the need for high feed-conversion efficiency and of avoiding a reduction in egg yields liable to occur during spells of exceptionally cold or hot weather, insulation of laying houses is becoming commonplace, particularly in the larger units.

To-day the industry is turning to greater control of environment for all classes of stock. Insulation of buildings is a major contribution to this control.

However, the greatest problem in poultry-house construction is that of ventilation. Inefficient ventilation is the most common cause of respiratory diseases and of debilitated stock which are, of course, susceptible to diseases of all kinds. A very large proportion of complaints of low egg production during the winter months are attributed to a run-down condition of the birds.

Unfortunately, little thought appears to have been given to this important matter in many houses. In some no adequate provision is made for ventilation, while in others ventilation is so arranged that the birds are exposed to draughts during the night. The result is the same—stock more or less debilitated, colds and similar complaints, slow growth of young stock and poor production from the adults.

In deep-litter houses and in buildings adapted to the system difficulty in keeping the litter dry frequently arises from insufficient ventilation to carry off moisture produced by the birds. During the summer months such houses are extremely hot and stuffy. Ventilation is of far greater importance than insulation. But ventilation and insulation are so closely related in maintaining a favourable environment that they should be considered together.

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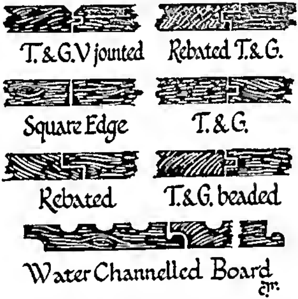

FIG 198A—TYPES OF BOARDING

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Cedar wood became very popular during the 1930s, when supplies were abundant and prices reasonable. Its usefulness for poultry-farm work is acknowledged by all having experience of it. The wood is reasonably hard and extremely durable, its

outstanding feature being that it resists rot, and therefore does not require annual applications of wood preservative It has a tendency to split rather easily, and care should be taken when working it As it is again available at prices which compare favourably with those of other classes of timber having regard to its rot-resisting property, it is now used extensively in poultry-house construction

Oak is too expensive for general use, and, it may be added, too hard for the handyman poultry-keeper Its use is restricted to gate-posts and other work where great strength and durability are required

Timber-trade Terms Logs are trunks of trees with the branches cut off

Baulks are logs that have been roughly squared Planks are pieces 2 to 6 in thick, 10 to 12 in wide

Deals are pieces not less than 8 in wide or more than 4 in thick

Battens are less than 9 in wide and 1½ to 2½ in thick, but the term batten is commonly applied to all pieces sawn from batten sizes

Boards are less than 2 in. thick

Quarterings are cut deals, from 3 in × 3 in to 4½ in × 4½ in

A "square" of timber equals 100 sq. ft and a "standard" equals 165 cu ft

It is understood in the trade that the thickness of timber refers to unplaned material About $\frac{1}{16}$ in is removed in planing each surface Thus 1-in boards planed one side would be about $\frac{1}{16}$ in less, if planed both sides $\frac{1}{8}$ in less One-inch planed boards are actually $\frac{7}{8}$ in thick, $\frac{3}{4}$-in are $\frac{5}{8}$ in, and $\frac{5}{8}$-in are $\frac{1}{2}$ in Similarly in making matchboard, rough boards lose $\frac{1}{4}$ in width in machining and $\frac{1}{4}$ in must be allowed for the tongue, hence a 5-in-wide rough board will make a 4½-in matchboard

When ordering timber, allowance must be made for short lengths or offcuts, which may amount to 10 per cent or more of the consignment, but, of course, offcuts are always useful for making food-troughs and other small equipment

The types of boarding commonly used on the farm are usually referred to by their initial letters—*e g* —

P.T.G. Planed, tongued and grooved
P.S.E. Planed, square edge.
P.T.G.V. Planed, tongued and grooved V-jointed.
P.T.G.R. Planed, tongued and grooved rebated.

All these types are known as matchboards

Weather-boarding. Matchboards are always fixed vertically, weather-boards horizontally. Thus the latter are not only more easily fixed, but throw off rain better. Further, if the lower part of the house should rot, repairs are much more easily carried out, since a length of one board only may need to be replaced, not the ends of many as necessary with matchboarding.

There are several types of weather-boards in common use. These are shown in section in Fig. 198B.

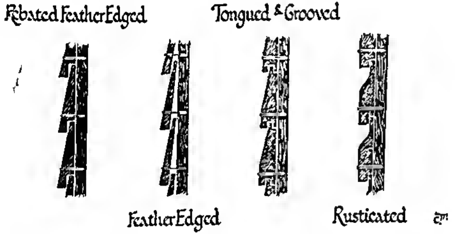

FIG. 198B.—TYPES OF WEATHER-BOARDING

Feather-edged weather-boarding is suitable for boarding up the lower part of the runs for the purpose of providing protection against wind and preventing cocks in adjacent breeding-pens from fighting. It is also useful for small lean-to sheds. It should not be used for poultry-houses, because the boards are simply lapped without rebate. As a consequence they readily warp, and dust and dirt collect between them. The principal objection to this type of boarding, however, is that unless the house is lined it is impossible to prevent draughts.

Of the other types of weather-boarding the tongued and grooved is the most satisfactory. This boarding is excellent for poultry-houses of all kinds.

Both matchboarding and weather-boarding should be $\frac{3}{4}$ in. thick (*i.e.*, $\frac{5}{8}$ in. actual) for exterior walls, $\frac{1}{2}$–$\frac{5}{8}$ in. for partitions, dropping-boards, etc., and $\frac{3}{4}$–1 in. for the floor.

Plywood. Plywood is commonly used for lining purposes. The cheaper kinds are unsuitable for outdoor use, but good-quality, resin-bonded plywood is suitable for folds and portable brooders as well as for large houses.

The quality of plywoods varies considerably. Only resin-bonded boards of the best quality should be used if they are exposed to the weather.

Hardboard. In recent years, owing to the high cost of timber, composite hard board has been used extensively both for interior and exterior work. Some houses are clad wholly of this material, which, if kept well painted or tarred, is very durable.

Hardboard varies in quality. Some of the cheaper kinds do not fully comply with this description and are suitable for lining purposes only, but the better-class hardboards are entirely satisfactory for outdoor use if properly fixed and given reasonable attention.

Mounted on light framing, superior grades of hardboard are widely used for nest-boxes, food troughs, interior partitions and doors.

Some hardboards are suitable for outdoor use without treatment. Among the best-known products of this type is Masonite Tempered Presdwood, a grainless, knotless and flawless compressed timber board of great strength and having considerable resistance to attack by fungi.

Masonite is available in three qualities for use on the poultry farm—Standard, Tempered and " Quatrboard Special ".

Both Standard and Tempered are suitable for all exterior work, but in the event of the Standard being chosen, the edges and face of the board should be well painted or treated with bitumen emulsion.

Tempered Presdwood can be used untreated for outer walls and doors of all types of poultry houses, and is extensively employed for the roofs of range shelters, arks, brooders and similar appliances. It is also suitable for dropping boards.

Masonite Quatrboard Special is of recent introduction.

This board is $\frac{1}{4}$ in thick and can be used too or work provided it is given treatment with bitumen emulsion or paint if exposed to the weather

In the case of the Presdwoods it is advisable before fixing the boards, to condition them by thoroughly wetting and allowing them to stand for at least twenty four hours before fixing to the framework This ensures that the boards will be free from buckle

Asbestos cement Sheets These are not ideal for poultry houses Compared with timber, the sheets are rather difficult to work, and they become extremely brittle with age Insulation qualities are poor Their low insulation value is the greatest disadvantage from the poultryman's point of view In their favour it can be said that they are relatively cheap, rigid, moisture resisting, draught proof and rat proof

Houses built entirely of asbestos cement sheets must be abundantly ventilated, preferably with doors and windows in each end to provide a through draught in hot weather In cold weather condensation is liable to be troublesome, but ventilation will reduce it

Conditions will be improved by insulation In houses used for chicks and laying stock, lining with fibre board or other material of high insulation value should be considered essential

On some farms insulation is effected by covering the roof externally with wire netting of 3 or 4 in mesh on which is laid glasswool covered with heavy duty roofing felt painted outside with aluminium

Felt joints are sealed with a bituminous compound

So treated, the roof has a very high insulation value

A cheaper method consists of covering the roof with a light straw thatch This is most readily accomplished by sewing straw to wire netting prior to fixing it to the roof Thatch should be covered with small mesh wire netting to keep out vermin

Galvanized Iron For practical purposes this material has similar properties to those of asbestos cement sheets, although, of course, it is not so durable

In common with houses of asbestos cement, conditions will be improved by insulation

Unlined galvanized sheets are more suitable for the open-fronted type of house or shelter used in hen-yards, for granaries, tool-sheds and so on

These sheets should be painted with red oxide or other paint, or tarred shortly after erection, especially in industrial districts, for when rust establishes itself deterioration is rapid

Aluminium Alloy For a period after the late war this material was used extensively for the construction of brooders, folds and other small portable equipment It is superior to galvanized iron, for of course it does not rust and is not such a good conductor of heat as steel It was frequently used in laying batteries

Galvanized iron is now much cheaper, consequently aluminium is employed on a very limited scale in appliance construction In recent years, however, bright aluminium sheets have become widely favoured for the roof and lining of broiler and larger laying houses The insulation value of aluminium is greater than that of iron and asbestos cement, provided the surface of the former is kept bright The thermal properties of aluminium are much impaired by oxidation

Wood-wool Blocks These blocks consist of wood wool lightly bonded with cement They are warmer than galvanized iron or asbestos cement sheets, and are suitable for poultry-houses occupying permanent sites They should be rendered in cement both inside and out to cover the rough surface which would provide hiding-places for insect pests and to protect them from the weather.

Lignacite Blocks Lignacite blocks are quite commonly employed for permanent buildings They are frequently used in broiler- and battery house construction Hollow blocks of very high insulation value are favoured by many building houses for these purposes

The blocks are absorbent and require dressing with a suitable waterproof solution obtainable from decorators and builders' merchants

Felt and Wire Netting Houses constructed of roofing felt and wire netting are entirely satisfactory, and for those who desire to build a cheap but efficient house these materials are worthy

of attention. They must be fixed to rigid framing. They are more suitable for small houses, shelters and verandas than for large flock houses.

Straw. Straw is commonly used for building houses for growing and adult stock, particularly where the hen-yard system is adopted. They may be built with straw bales, thatch or straw packed between wire netting. The latter method of construction is frequently used in building wind-breaks surrounding runs or "yards".

Breeze-block, Concrete, Brick. All these materials are suitable for the larger types of permanent buildings—granaries, stores, deep litter, battery and multi-unit brooder houses and incubation rooms. It may be more economic to build with one of

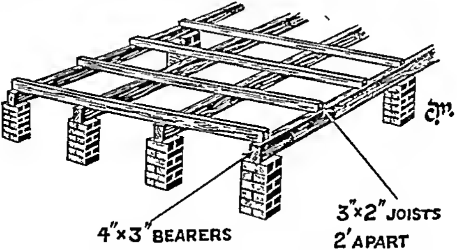

FIG. 198C.—CONSTRUCTION OF FLOOR FOR PERMANENT HOUSES

these materials than timber. Prevailing costs should be studied.

Flooring. *Wood.* For houses occupying permanent sites the floor should be ¾- or 1-in. P.T.G. matchboards or well-made concrete, or rammed earth.

Prior to the introduction (or re-introduction) of the deep-litter system, wood was considered the most suitable material. All houses having timber floors should be mounted on brick or concrete piers 1½–2 ft. high. This is essential to ensure a dry floor, a long life for the timber and freedom from rats. In no circumstances should wooden-floor houses be placed on the ground.

The piers should be on firm footings This is important because if on account of settlement some of the piers fail to give the necessary support, the entire structure of the house will be subject to strains and early damage

Piers 9 in square (i e, the length of a brick) should be 5 or 6 ft apart (from centre to centre), and the house should be supported on bearers of adequate strength to carry the weight Bearers should not be less than 4 × 2 in for a 5-ft span, 6 × 2 in for a 6- or 7-ft span In ordinary circumstances a 5- or 6-ft span should not be exceeded

Floor joists should be 3 × 2 in, and should be placed 24 in apart, the span not exceeding 6 ft It is always wise to err on the side of generosity in matters of this kind, for the floor may at some time be called upon to carry a greater weight than anticipated at the time it was built

Sizes of all supporting timbers naturally depend on the distance apart and length of span, but the above will be suitable for general work on the farm Much lighter timber would, of course, be used for small houses, night-arks and portable brooders—*e g*, a 2 × 1½-in joist would be suitable for 18 in spacing over a 4-ft span, 3 × 1½ in for the same spacing over a 6 ft span

It will be found that 3 in × 1½ in is a most useful size for the framework of the larger houses, the 1½ in face being vertical to provide maximum resistance to horizontal pressure

Concrete Much prejudice exists against concrete for poultry-house flooring, largely because many who have used this material have not made the floors properly

Unless a concrete floor is substantially and properly constructed it will soon become a nuisance, and rats will over-run the house A well built floor can be made vermin proof, it is clean, sanitary, everlasting and upkeep costs are nil

When laying a concrete floor remove the top spit of soil and put down a layer of gravel or broken brick, *i e* the "hard-core" This should be allowed to settle Rolling at intervals will assist the process, particularly if this is done after rain or soaking with the hose pipe If the work cannot be delayed the hardcore should be "watered in" with a hose, water being used copiously

In order to keep out rats, the floor should be surrounded by a concrete wall extending 18 in. below the surface of the ground, or asbestos-cement sheets or fine-mesh wire netting should be sunk into the ground to this depth. Wire should be dressed with a mixture of tar and pitch when used for this purpose. For larger buildings a concrete or brick retaining wall extending not less than 12 in. above ground level should be constructed, the house being supported by the wall, which should have a damp course.

In all the larger houses in which a tractor may be taken at cleaning time, concrete should be laid to a depth of 4 in. This is the usual depth, but in small houses in which the floors will never carry a heavy load 3 in. concrete is adequate.

A damp course in the floor is not essential but desirable. It will assist in keeping the litter dry and the house warm. A damp course can be provided by first covering the hard-core with concrete to a depth of about 2 in. and laying tarred paper or roofing felt over it. A dressing of tar and pitch is also effective.

Two inches of concrete should be laid over the damp course. The top of the floor should be at least 6 in. higher than the level of the surrounding ground, to ensure dryness.

One part of cement, 2 parts sand, 4 parts gravel, shingle or broken brick is a suitable mixture for floors.

This should be finished with a layer of finer material, *e.g.*, 1 part cement, 2 parts sand, 4 parts $\frac{3}{4}$-in. gravel, worked down with a shovel to give a reasonably smooth surface, or should a very smooth surface be required the coarse concrete can be "floated off" with cement and fine gravel (1 : 4).

The surface layer must be put down while the concrete base is still soft.

The cement should be thoroughly mixed with the sand and coarse aggregate before water is added. Mixing should be done on a smooth concrete surface or on a mixing-board, and it is well to lay it down as it is freshly mixed, mixing being done in batches.

Hand mixing of concrete is laborious. If the area to be covered is extensive it will be wise to use a mixer—obtainable from a plant hire firm at reasonable cost.

When mixing concrete only sufficient water should be used

to ensure an easily workable mixture. Too much water impairs the quality of the concrete and results in a dusty surface.

The setting of concrete is due to a chemical reaction; it is not caused merely by drying.

As a guide to quantity of materials required about $4\frac{3}{4}$ cwt. cement, $10\frac{1}{2}$ cwt. sand and 20 cwt. gravel will make about 1 cu. yd. of a 1 : 2 : 4 mixture or sufficient to cover about 9 sq. yd. to a depth of 4 in.

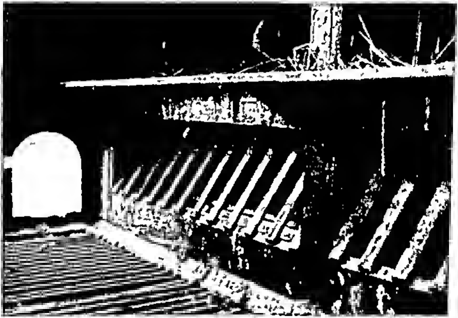

Photo: Modern Poultry Keeping

FIG. 199.—FOOD-TROUGHS BEHIND GRILL, WITH NEST-BOXES ABOVE, IN SLATTED-FLOOR HOUSE

Should the floor area exceed about 200 sq. ft. expansion joints are advised. The joints are made by removal of the boards (shuttering) in the concrete when the latter has set and filling the spaces with a bituminous compound of the type that will retain some measure of plasticity.

Expansion joints 12–15 ft. apart should prevent the concrete cracking, provided the floor is well laid.

Concreting should be undertaken in mild weather. If it is necessary to do the work in frosty weather one of the compounds that speed up the hardening process should be included in the

mixture In practice, these compounds are often used irrespective of weather conditions, for the floors are then sufficiently hard for walking over in a matter of a few hours

In hot weather steps should be taken to prevent too rapid drying by covering the surface with wet sacks These must be sprayed or sprinkled with water as often as necessary

Earth Floors Earth floors are favoured by some poultry men, largely on account of their economy Despite the claims made for them, they cannot be regarded as ideal for brooder or laying houses They are difficult to keep clean and tend to be dusty in summer and damp in winter

For adult stock on deep litter, well made earth floors have proved satisfactory, so much so that many prefer them to those of wood or concrete, maintaining that they are warmer, and therefore provide more favourable conditions for the organic action of the litter It is doubtful whether these claims could be substantiated, the main advantage, if not the only one, of this type of floor lies in its low capital cost The greatest disadvantage is that in the event of the floor becoming contaminated with parasitic worms and pathogenic organisms no completely effective method of disinfection is known In these circumstances replacement of the top soil is advised

On a dry, well drained site a satisfactory earth floor can be made by putting down a layer of soil and ramming it until the surface is hard If the site is not well drained the top soil should be replaced with a layer of rubble about 4 in deep, and after ramming about 3 in soil should be placed over it and well rammed

The rubble foundation must be well covered with soil and the floor consolidated to prevent the birds breaking up the surface

Drainage around the perimeter of the site is advised The roof should be fitted with spouting and soak away Precautions against rats should be on the lines recommended for concrete floors

Slatted Floors These are most commonly used for birds kept on free range or at least in large runs or folds But they are equally suitable for sun balconies attached to houses for growing and adult stock They are frequently employed for the latter purpose when many hundreds, possibly thousands, of birds are reared on a small acreage

On some farms adult birds are permanently housed on the balcony or veranda system Slatted floor houses and verandas occupying permanent or semi permanent sites should be fitted with droppings boards or placed on a concrete yard

Slats are usually 1 in wide at the top, 1 in deep and ¾ in wide at the bottom They are usually spaced 1 in apart, but for adult birds many prefer 2-in × 1-in slats (2 in side horizontal) spaced 1¼ in apart

Floors should be built in sections to ensure easy removal for cleaning (see p 607)

Wire Floors Wire floors, long used for verandas and for small houses, are now installed in large flock houses Many deep litter houses have been equipped wholly or in part with wire floors

As with slatted floors, wire floors should be built in sections for easy removal, and the frames should be cross braced to prevent the wire sagging

For chicks ½-in mesh 19 gauge wire netting is commonly used, for young growing stock the mesh should be ¾ in × 18 gauge, for birds from about seven weeks old, and for adults 1-in mesh × 16 gauge

Wire netting of the above standard will prove satisfactory, but welded wire is becoming increasingly popular, and is now used in units of all types, from small brooders to large flock laying houses

With this type of wire it is customary to use ½ in mesh × 16 gauge for chicks, 1 × ½-in mesh × 16 gauge for the second rearing stage (3 8 weeks) and thereafter 3 in × 1 in 10 or 12 gauge, 12 gauge being preferred

Roofs The roof of a poultry-house should be weather-proof and a poor conductor of heat It should be soundly constructed, to ensure durability and low maintenance costs

Rafters should be spaced about 2 ft 6 in apart, and should be 3 in × 1 in for a 3 ft span, 3 × 1½ in for a 6 ft span Except for the smaller type of house 3 × 1½ in will be suitable for the majority of houses, purlins being employed for spans exceeding 6 ft For large houses 18–24 ft wide, rafters should be 5 × 2 in with 5 × 1½-in purlins Tie beams 10–12 ft apart should be about 6 × 2 in with 3 × 2 in king post and two 2 × 2 in struts

Roofs so constructed will carry heavy covering and will bear the weight of snow. Roof pitch should be about 1 : 2; *e.g.*, in a house 24 ft. wide, 5 ft. at eaves, the ridge should be about 11 ft.

But for large-scale commercial egg and broiler production houses exceeding 24 ft. width are advised. Modern units are usually of 30–40 ft. for laying stock and up to 48 ft. for broiler chicks, although for the latter houses of about 37 ft. width are favoured by many producers.

For wider houses roof principals should be correspondingly stronger than in narrower houses so popular years ago, unless adequately supported by stanchions. Not more than two stanchions in the width of the house are advised, however, because of obstruction.

In houses exceeding 24 ft. width or thereabouts rafters should be 6 in. × 3 in., purlins 4 in. × 2 in. and stanchions 4 in × 4 in. with 6-in. × 1-in. tie beams bolted on each side of the struts.

Houses of this type should have a lower roof pitch to avoid excessive height at ridge, which is neither necessary nor practical. A pitch of about 1 : 3 is satisfactory for houses having roofs of conventional construction.

Even lower roof pitch is advised in houses exceeding 40 ft. span, down to about 1 : 8.

The roof-boards should be ¾ in. or ⅞ in. T.G.M., covered with a felt of good quality. The roof should be creosoted, and the creosote allowed to dry before the felt is laid on.

Modern roofing material is very different from the old-fashioned felt. It is long-lasting, and will require no attention for a number of years. Then an occasional dressing of a special emulsion supplied for the purpose, or of tar and pitch, is all that is necessary.

Various well-known brands of felt are available, and these should be used in preference to the common felt. The felt should be unrolled and exposed to the weather for at least a week before fixing.

The strips of felt should be laid parallel to the length of the house (*not* from ridge to eaves), and the joints should be sealed with specially prepared solution supplied by roofing-felt makers, and fixed with galvanized tacks.

If the work is properly done the result is a sound roof that will

last for many years without attention. Wood strips often seen on felt roofs should not be used.

A better method of fixing felt is to dress the roof with cold bitumastic solution and simply lay on the felt.

Mineralized roofing felt, if properly fixed, will last a lifetime without attention, as will felt tile shingles.

Roofing felt and felt tiles are now available in several colours.

It will be noted that T. and G. matching is recommended. Plain boards should not be used, because the wind will blow between them and loosen the felt. Moreover, when repair or maintenance work necessitates walking on the roof, plain boards give a little, and this is often sufficient to tear the felt.

Water-channelled boards have attained considerable popularity, more particularly in slatted-floor house construction. They make a satisfactory roof provided the timber is well seasoned.

Galvanized-iron sheets laid over ¾-in. T.G.M. make a first-class roof. Although this method of construction is expensive, many claim that it is the cheapest in the long run. The timber should be creosoted and the sheets treated with red oxide paint. Asbestos-cement sheets are also used for this purpose. They should be corrugated to provide a greater degree of insulation.

Asbestos-cement tiles are used only for the larger permanent buildings, such as incubator houses and granaries.

If galvanized or asbestos sheets are used without boards the roof should be lined. Unlined houses constructed of these materials are too hot in summer and too cold in winter for the most economic production of eggs or meat.

As previously mentioned, aluminium sheets are now being used more extensively in roof construction. A double skin of the sheets with 1-in.-thick Fibreglass blanket between them provides a roof of exceptional thermal insulation value. This method of roof construction is adopted in some of the large egg-production and broiler units.

Roofs are now constructed with so wide a variety of materials and combinations of materials that it is impossible to make reference to all of them.

The relative cost of different roofing materials, as indeed that of building materials generally, should be considered.

For example, it may be cheaper to construct the roof with asbestos cement sheets (including insulation) than with timber and roofing felt Current prices should be studied

Lighting Houses should be well but not excessively lit Too many windows make the houses cold in winter, hot in summer Moreover, if the birds are kept in confinement too bright interiors tend to induce cannibalism

In the early days of the intensive system houses fitted with shutters that would provide an open front were considered essential Today this method of lighting is rarely applied, since it is the usual practice to have relatively small windows, thereby enhancing insulation, and to rely on dietary sources of vitamin D_3

As in all cases of this kind, extremes should be avoided For intensively reared, floor brooded chicks, window area need not exceed about 12 per cent of the floor area, for rearing in batteries and tier brooders about the same window area will be adequate, for semi intensive field houses not more than 15 per cent should be provided

In deep litter houses window area equivalent to 5 per cent of the floor area will be sufficient Many houses have considerably less window area It is assumed, of course, that the windows are well sited, kept clean and that in intensive houses the walls and ceilings are whitewashed or covered with material that reflects the light

In laying battery houses windows equivalent to about 8 per cent of the floor area are required, but as a rule additional roof lighting is necessary to give sufficient light between the rows of cages Roof light area should not exceed 3 per cent of floor area

In recent times windowless houses for the deep litter, wire (and slatted) floor and battery systems have been introduced to provide controlled environment In these houses light patterns are applied

Ventilation Ventilation of the poultry house is of supreme importance It is a matter to which considerable thought should be given, because failure to provide an abundance of fresh air without draught is by far the most common cause of respiratory diseases to which poultry are heir The effect of poor ventilation is frequently seen, not in actual disease, but

in the debilitated condition of the stock Compelled to spend many hours in a stuffy atmosphere, the birds get run down, they are unable to assimilate their food in a normal manner, and hence the growth of young stock is retarded and egg production from adults is low

Exposure to draughts is equally injurious It predisposes the birds to colds and other respiratory diseases, and may cause chilling of the internal organs Even if these complaints do not arise, the birds are uncomfortable and unhappy—and, as every poultry-man knows, an unhappy bird will not give the best performance of which it would be capable were environmental conditions satisfactory

In recent years considerable attention has been given to ventilation, and great progress has been made Perhaps its importance can best be emphasized by pointing out that relative to their body-weight, birds require about two and a half times more air than man The ventilation of poultry houses must therefore be much more abundant than that of houses for human habitation

In addition to satisfying the birds' requirements for oxygen, ventilation must be sufficient to carry off a considerable quantity of moisture if good conditions are to be maintained in the house

It is estimated that at normal temperature 100 light-breed birds will produce by respiration about 12 lb of water daily The amount of water produced in the droppings is far greater At the time of voidance, droppings contain up to 80 per cent of water, hence 100 birds will produce about 50 lb of water daily

All this water plus that due to condensation and spillage must be removed from the house

Ventilation requirements are now calculated with greater precision than formerly, but this is an essentially practical problem, and its solution will not be found by the application of hard and fast rules, because conditions vary from building to building and from farm to farm so widely

Until comparatively recent times it was customary to work out ventilation needs on the basis of about eight air changes per hour when all doors and windows were closed

This is calculated by multiplying the cubic capacity of the house by eight and then providing 12 sq in free inlet area

together with about 6 sq. in. extraction area per 1,000 cu. ft.

This method of calculation has been criticized on the ground that (*a*) it provides too much ventilation, (*b*) that it does not provide sufficient, (*c*) that it does not take into account the number of birds per 1,000 cu. ft. But it was never intended to be more than a rough basis, and if it is so accepted and ventilation adjusted to suit prevailing weather and other conditions it will be found satisfactory. On the assumption that eight air changes per hour are adequate, Table 44, page 581 indicates the approximate amount of ventilation required.

Considerable latitude is permissible with regard to this important matter. The poultry-man should not apply rules, however soundly based, too rigidly. He should apply common sense, avoiding draughts, stuffiness and condensation. He should be guided by his eyes and nose. Other recommendations for the ventilation of poultry houses include 3 sq. in. inlet and $1\frac{1}{2}$ sq. in. outlet per bird; 4 sq. ft. inlet, 2 sq. ft. outlet per 250 birds.

Unless power ventilation is installed, however, the rate at which air passes through a building will depend on the difference between external and internal temperature and the velocity of the wind, assuming, of course, that air inlet and outlet are not restricted.

This being so in all houses dependent on natural-draught ventilation, the fullest use should be made of doors and windows. In hot weather it is impossible to provide too much fresh air; indeed, throughout the summer months windows should be kept open day and night and wire frames should replace doors.

On the contrary, in cold weather very little ventilation is needed, because the greater difference between internal and external temperature accelerates air flow into the house.

In large deep-litter houses it is possible to rely entirely on the windows for ventilation, but it will be understood that in these circumstances they will require quite fine adjustment from time to time. As a rule, ridge ventilation should be provided, preferably by extractor cowls of efficient design with control shutters in the cowl shafts.

When special provision is made for inlet ventilation inlets should not be less than 3 ft. from littered floors; they may be

fitted under the windows or at the eaves. They should be controlled by shutters and baffled.

Cold air entering the house too close to the floor tends to retard litter activity, and in brooder houses may create dangerous floor draughts.

In laying battery houses, however, inlets can be fitted at about floor level, or if desired air ducts can be built in the floor, air entering under the cage blocks. Two popular methods of baffling ventilators are shown in Fig. 200.

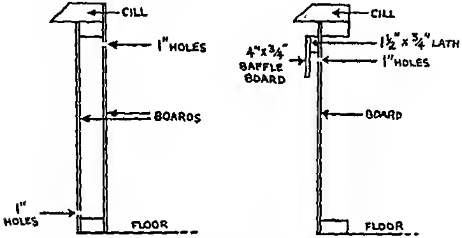

FIG. 200.—BAFFLED FLOOR VENTILATION

Control may be effected by small shutters or the "hit-and-miss" principle. The latter is shown in Fig. 202.

A type of inlet ventilator suitable for brooder- and laying-houses, including deep-litter houses, is shown in Fig. 201.

An opening of appropriate size is cut in the side of the house and covered with small-mesh netting. A three-sided box-like structure with an opening near the top is attached over the opening *inside the house. The ventilation is controlled by a* small sliding shutter. The top of the ventilator is removable for cleaning purposes.

All floor inlets should be covered with small-mesh netting or perforated zinc to keep out vermin. Should perforated zinc be used the inlet area should be increased to allow for the area taken up by the metal.

The free inlet area should be twice the area of extraction.

As a general rule, inlet ventilators should be fitted about 10 ft. apart along both sides of the house.

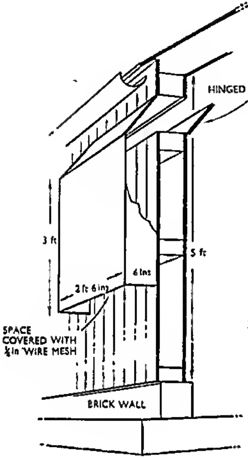

FIG. 201.—A TYPE OF INLET VENTILATOR SUITABLE FOR BROODER- AND LAYING-HOUSES

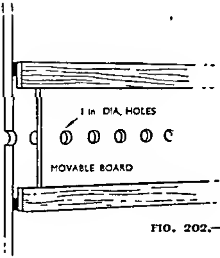

FIG. 202.—HIT-AND-MISS VENTILATION

Extraction is most effectively ensured by fans. Many of the larger houses are now equipped with them. They may be kept running continuously or only during hot or muggy weather. They have solved many ventilation problems in deep-litter, broiler- and other large houses.

Very frequently fans are mounted in the cowl-extractor shafts. This is a most suitable position, because when placed elsewhere, *e.g.*, in the gables, they may draw some of the air from the ridge ventilators, thus impairing the effectiveness of the fans.

When fans are fitted in cowl shafts, however, cowls may offer resistance to the larger volume of air the fans are pulling up. It is wise to consult ventilation experts.

In broiler houses and the larger egg-production units fans are frequently coupled to time switches and/or thermostats.

When coupled to thermostats it is theoretically possible to maintain level temperature and other conditions.

In practice this is not so, particularly with regard to humidity. If all fans are coupled to thermostats condensation may occur in the winter months. For this reason it is advisable to have one or more of the fans under manual or time-switch control.

Although there is no accepted standard in routine when dual control is adopted, not infrequently time switches are set to operate the fans for 10 minutes at 30-minute intervals. Thermostats are often set to bring fans into action when the temperature rises to 60° F., the thermostats, of course, superseding the time switches.

When estimating size and number of fans required air replacement at the rate of 1½–2 cu. ft. per minute per lb. liveweight is now recommended for chicks up to broiler weight and 1–1½ cu. ft. per minute per lb. liveweight for adult stock.

The amounts are higher than previous standards; they are advised as a safety measure to cope with increased intensity of stocking and periods of very hot weather and to combat respiratory diseases.

These allowances are maximum under conditions prevailing in this country. They provide adequate ventilation in summer. In winter ventilation should be reduced; in cold weather only about one-sixth the amount of ventilation needed in summer will be necessary.

Table 43 shows air movement (in cu. ft. per minute) effected by fans of different size.

TABLE 43

Air Movement by Fans (Data by courtesy London Fan & Motor Co. Ltd.)

Fan dia., in.	Fan speed, r.p.m.	Air movement, c.f.m.	Sound level.
12	900 1,400	700 1,050	VQ Q
15	900 1,400	1,250 2,000	Q FQ
18	900 1,400	2,150 3,400	FQ FN
24	460 520 700 900	2,900 3,300 4,400 5,750	Q Q FQ FN

Sound Levels Very Quiet (VQ); Quiet (Q); Fairly Quiet (FQ); Fairly Noisy (FN).

In normal circumstances fans should be placed about the same distance apart as the width of the house. In large houses, however, compliance with this general rule will require a large number of fans, costly wiring and a considerable number of outlets in the building.

Although this is the usual method and is certainly a simple one, the single or perhaps two-fan system with ducting should be considered.

The latter system provides a ready means of employing a stand-by petrol-driven power unit in the event of electrical failure, it reduces interference with the house structure to a minimum and, provided the ducting is designed and sited efficiently, it will ensure uniformity of air circulation. Maintenance costs are low.

Moreover, this system will give a far greater measure of control than can be obtained with variable-speed fans employed in the conventional manner.

Adequate air inlets are essential. Free inlet area should not be less than 4 sq. ft. per 1,000 cu. ft. per minute being drawn out by the fans.

Inlet ventilators should be evenly distributed. It is suggested

that four, each of 1 sq. ft., should be provided per 1,000 cu. ft. air extraction.

Reverse Ventilation. In some large-scale broiler, deep-litter and battery units, including some farm and other buildings adapted for these purposes, the system of ventilation is in reverse of the conventional direction.

Instead of air being drawn in at eaves level or lower and extracted through the roof, it is drawn in through the roof ducts.

The fans thus build up pressure in the building, and air is forced out through vents. The latter, which may be about 12 or 18 in. from the floor, should be baffled and controlled.

A system of ducting is essential for this system to ensure even distribution of incoming air without draught.

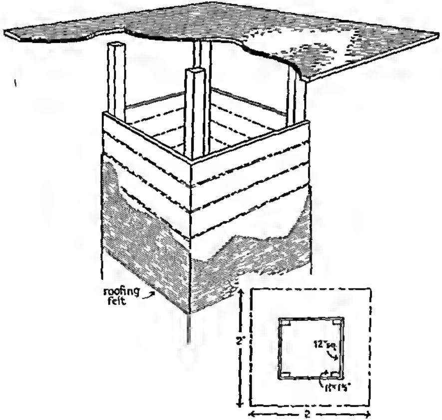

FIG. 202A.—COWL VENTILATOR

This type of cowl ventilator may be made of metal or wood. The corner supports may be of 1½ in × 1½ in. to 2 in. × 2 in, according to size of vent. The cover should be twice the area of the shaft. Ventilation can be controlled by a shutter fitted in the shaft and operated by a cord.

Cowls are of diverse types A simple design for a home made cowl is shown in Fig 202A Actual dimensions will vary according to the size of the house

Extractor cowls not fitted with fans should not be placed more than 20 ft apart It is advisable to fit ventilation shafts with shutters

TABLE 44

Amount of Ventilation Required

Size of House	Capacity in cu ft × 8	Size round Diam in	Shaft sq in	No of Ventilators	Free Inlet Area sq in
6 × 6 ft Av ht 7 ft	2 016	4	$3\frac{1}{2} \times 3\frac{1}{2}$	1	25
10 × 8 ft Av ht 7 ft	4 480	6	$5\frac{1}{2} \times 5\frac{1}{2}$	1	60
20 × 12 ft Av ht 8 ft	15 360	9	8 × 8	2	250
60 × 18 ft Av ht 10 ft	86 400	14	12 × 13	4	1 200

Ridge caps Where cowl extraction is not employed an efficient ridge cap will be necessary The orthodox, inverted V type does not meet this need It does not ensure efficient extraction, on the contrary, under conditions that commonly arise on the farm, far from extracting air, it may create down draught

The horizontal ridge cap is much more effective, but in many home made, and in some factory made, houses the clearance is too great, both between the sections of the roof and between the roof and ridge cap

The amount of clearance may be calculated from the above table From this it will be seen that in a house 20 ft × 12 ft, with an average height of 8 ft, the extraction area required is 128 sq in Therefore in a house of this size fitted with a ridge cap a clearance of $\frac{5}{8}$ in throughout the entire length will provide 150 sq in extraction, which is fully adequate

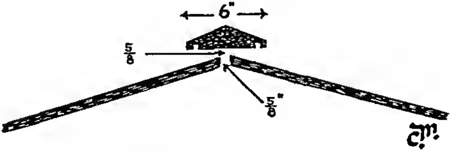

FIG 203—HORIZONTAL RIDGE CAP

The ventilation of houses already fitted with V capping may be much improved by fixing vertical-boards on either side of it, with only sufficient clearance between boards and roof to permit rain to drain off

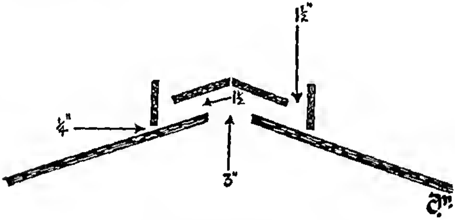

FIG 204 —VENTILATION
' V ' type ridge cap with side protection which prevents down draught

Insulation. Long regarded as unjustified in this country, the value of insulation is now recognized. Insulation is accepted as essential in broiler-house construction, and it is being applied on an increasing scale to the larger battery and deep-litter houses

In commercial table-poultry and egg production the producer is seeking greater control of environmental conditions to ensure more efficient production Insulation prevents that wide fluctuation in temperature that occurs in houses of conventional construction

Insulation contributes to greater efficiency in food conversion by growing and laying stock, it is a safeguard against arrested growth and a slump in egg yield that are associated with extremely hot and cold weather

Insulated houses are warmer in winter, cooler in summer, they simplify ventilation problems and are of considerable assistance in establishing deep-litter in cold weather and maintaining the litter in good condition during the winter months

Care should be taken to vapour seal the lining from the roof—and the walls if the house is completely lined Unless the lining provides a barrier, the warm, moisture-laden air will escape through the lining, condense on the cold roof and

existing walls and fall back to soak the lining. The insulation property of all materials is destroyed by moisture.

The importance of vapour sealing must be emphasized, because without it the effect of insulation may be completely nullified. Water is a good conductor of heat, but in addition it may so weigh down the insulation material that it breaks away from the roof and walls.

The choice of vapour-sealing materials is wide. Those most commonly used in poultry-house construction include Sisalkraft paper, thick-gauge polythene sheeting, and certain plastic paints and plastic solutions. Some insulation boards have a vapour-proof surface.

All joints in vapour sealing must be covered with sealing strips or suitable sealing compound to provide a complete vapour barrier.

When insulating buildings, air-inlet ducts passing through cavity walls should be sealed off from the cavity to provide still air pockets between outer wall and lining. This will increase the insulation value of the building.

Similarly, the lining material should be completely sealed around air-outlet ducts, and it is advisable also to lag cowl shafts and ducting between ceiling and roof, otherwise they may be a source of dampness due to condensation.

There is a wide choice of materials suitable for poultry-house insulation, some of them having a very attractive appearance. These material differ in their insulation value per unit of thickness; they also differ in many other properties, *e.g.*, weight, smoothness and reflectiveness of surface, ease of fixing, resistance to fire, and to attack by moulds, vermin and disinfectants.

It should be stressed that the softer materials, such as "Fibreglass", fibreboards and polystyrene, must be protected from the birds, for they find them a pleasant change from the normal diet. The lower part of the house should be insulated with hardboard or the lining covered with asbestos or metal sheets.

The effectiveness of insulation in building construction is usually expressed in its *U* value, which is the measure of loss of British thermal units (B.T.U.) per sq. ft. per hour per °F. Thus the lower the *U* or thermal transmittances value, the higher the insulation property.

Insulation value is also expressed in terms of thermal conductivity (k) which is defined as the quantity of heat (B.T.U.s) passing through 1 in. thickness of the material per sq. ft. per hour per 1° F. difference between the faces.

Thermal transmittance (U) is not related to the thickness of the material; it refers to heat transmitted between the two sides of the construction, whereas thermal conductivity refers to heat transmitted through material 1 in. thick.

At present the U value is most frequently employed as a measure of insulation property. The following table shows the U value of a number of materials in common use. Data have been derived from a number of sources and show approximate values.

TABLE 45

Insulation Value of Building Materials

Material	U value
4½ in. brickwork	0.64
9 in. brickwork	0.47
11 in. brickwork cavity	0.32
11 in. brickwork cavity filled with glass wool	0.14
Corrugated iron	1.5
Asbestos-cement	1.4
Aluminium sheets	0.8
4 in. concrete	0.68
Single glass	1.13
Double glass ¼ in. cavity	0.58
1 in. timber (floors)	0.4
¾ in. timber covered roofing felt	0.6
Corrugated asbestos-cement sheets lined with	
½ in. fibreboard	0.38
2 in. straw slabs	0.22
1 in. wood wool slabs	0.35
¾ in. expanded polystyrene ("Poron")	0.2
1 in. expanded polystyrene	0.16
1 in. fibreglass	0.17
Asbestolux lining	0.2
⅜ in. gypsum plaster board	0.32
Sisalation foil surface downwards	0.32
1 in. T. & G. boarding covered felt, lined Sisalation foil surface downwards	0.22
Double skin aluminium sheets interlined with 1 in. fibreglass	0.1

Houses of conventional timber construction without insulation have a U value in the region of 0.6. With simple insulation it can be improved to 0.3, which is satisfactory for laying stock, but for broiler production houses should have a U value of 0.2–0.1.

In some houses aluminium-foil-faced paper is used both for insulation purposes and as a moisture seal.

Many insulation boards, including plaster boards, have aluminium foil on one surface only. They should be fixed with the foiled face towards the roof and walls and the joints covered with a suitable adhesive tape, the under-surface being painted with aluminium.

Photo J. H. Sankey & Son, Ltd., Barking, Essex

FIG. 204A.—A DEEP-LITTER HOUSE WITH ROOF AND WALLS LINED WITH SISALATION REFLECTIVE (THERMAL) INSULATION

A plastic-faced plaster board ("Paramount") is now available with aluminium foil on the reverse side. Finished in white, this board reflects the light and is easily cleaned with water containing a mild detergent.

Sisalkraft reinforced waterproof building paper bonded on one or both faces with a foil of burnished aluminium also serves the dual purpose of insulation and vapour barrier. This product, known as Sisalation Reflective (Thermal) Insulation, is easily fixed to timber framework by means of light wood battens nailed at 12-in. intervals.

Expanded polystyrene ("Poron") is a comparatively new material for poultry-house insulation, but in recent years it has been used on an increasing scale It is a closed cell rigid product having only about one-tenth the weight of cork

Snow white in appearance, "Poron" insulation provides a highly reflective surface Supplied in sheets of various size and thickness, it is readily cut and can be fixed with nails or adhesives

"Poron" can be painted with a water-bound emulsion paint or PVA Emulsion, and provided a special primer and sealer is used, certain oil-bound or synthetic paints can then be applied "Poron" can be supplied cement rendered or plastered or with a variety of finishes, including roofing felt

Asbestos composition boards of certain kinds provide high insulation value combined with hygienic attractive surfaces

Among them "Asbestolux" is a general purpose board which is free from the rigidity normally associated with cement-bonded sheets, it will not promote mould growth and is completely fire safe

"Fibreglass" is a flexible bonded mat of long, fine glass fibres It is perhaps the most commonly used product for lining cavity walls and roofs Many modern broiler, battery and deep-litter houses have Fibreglass between the walls and interior lining and between ceiling and roof It is rot-proof, non-hydroscopic and is an effective deterrent to vermin

Probably the simplest method of insulating the roof of existing buildings is to fit wire netting at eaves level and lay building paper over the wire and then Fibreglass on top of the paper. But it is wiser to have insulation of this or any other material following the line of the roof, since this ensures more efficient ventilation in houses not equipped with fan extraction

Fibreglass can be bonded or stapled to lining boards for roof and walls

There are many other insulation materials available, and new types are being marketed from time to time

Housing on Free Range. For free-range work, poultry-houses must be comparatively small and readily portable In no circumstances should houses occupying permanent sites be used, for it is extremely difficult to keep the land in the immediate vicinity clean Birds are not great foragers, they do not

go far from their houses. They concentrate on the ground within about 10 yards of the house, while neglecting that farther afield. In order to ensure that the land be fully utilized, portable houses must be employed.

There are two types of house in common use: the small solid-floor house usually mounted on wheels, and the slatted-floor house mounted on wheels or skids.

For both types skids are preferable, for although a house on wheels is more easily moved over hard ground than one on skids, on soft ground the reverse is true. Houses on wheels frequently sink into the ground up to the axles in wet weather unless lengths of stout boarding are placed under them.

Of the two types, the house on skids is the most satisfactory. Small houses so mounted can be moved by the staff, while the farm horse or tractor should be called in to deal with the larger houses.

Portable Solid-floor House. The portable solid-floor house often referred to as the " farmer's poultry house ", and at one time largely displaced by the slatted-floor house is now rapidly regaining its popularity. It provides greater protection than the slatted-floor house, and is therefore favoured for the more exposed farms, particularly in the Northern counties.

Unlike the slatted-floor house it may be used without alteration for all classes of stock—chicks, growers, layers and breeders. In inclement weather chicks may be kept in total confinement in these houses, at least for short periods—a very appreciable advantage in the British climate—and other stock are able to keep themselves occupied without going outside, a particularly important point when snow lies on the ground.

These houses, in common with others, are not standardized in size or design. They may vary from, say, 6 × 4 ft. to 8 × 12 ft. or even larger, and they may have lean-to or full-span roofs.

A house 6 × 8 ft., efficiently ventilated, will accommodate about thirty-five adult birds if adequate perch space is available or up to forty-eight if fitted with a slatted roost; for these houses are little more than places in which the birds roost and lay. Hence they may be comparatively heavily stocked.

The lean-to roof is not recommended except for very small houses. Houses having lean-to roofs are difficult to ventilate,

they are not so convenient for the attendant, they are less rigid and are more liable to be blown over.

Full-span roofs have now become almost the standard type for the larger and the majority of the smaller houses in common use to-day.

A modern solid floor portable house is shown in Fig. 205. This house is 9 ft. × 7 ft., 4 ft. 6 in. to the eaves, 6 ft. 6 in. to ridge. It is a combination of a slatted floor and semi-intensive house. The birds roost on a raised slatted platform mounted

Photo I ic Hallam Ltd

FIG. 205.—TYPE OF PORTABLE HOUSE SUITABLE FOR HOUSING ON FREE RANGE

over droppings boards, leaving the entire area of the solid floor free from obstruction.

The nests are placed at a lower level than the slats, thus obviating the need for closing the nests at night. There are floor-lights at the back, and controlled ventilation between slats and droppings boards. For easy cleaning the droppings boards slide out from the back. If desired, the slats and droppings boards may be placed near the floor for training growing stock to go upstairs to bed.

Slatted-floor Houses. The slatted-floor house is still very popular, largely because the cost of housing is low and the ventilation in a well-designed house so efficient that the birds usually remain in good health.

This type of house is primarily intended for free-range work, although on countless farms it is used for birds confined to grass runs. It should, however, be pointed out that as the

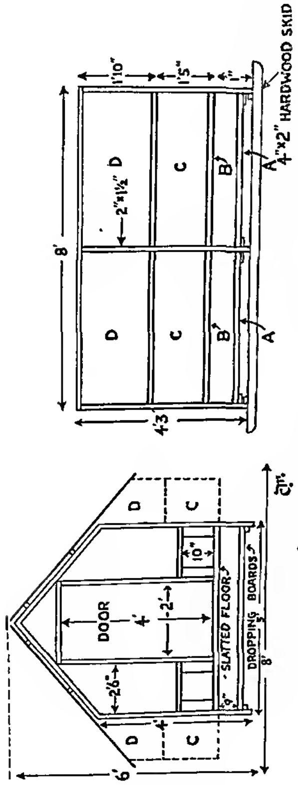

FIG. 206.—SLATTED-FLOOR HOUSE. END AND SIDE SECTIONS

A. Droppings boards. B Slatted floor. C. Food hopper. D. Nest box.

house simply provides roosting and laying quarters, it should not be employed where large runs cannot be provided. Good range is essential for the success of this system of housing. If used with runs, alternate runs should be provided, each having an area equivalent to not less than 10 sq. yd. per bird, or a total of 20 sq. yd. per bird for the two runs. Even so, it is desirable to move the houses when the ground shows signs of wear.

On some farms slatted-floor houses have been converted into static units for growing and/or laying stock by attaching wire or

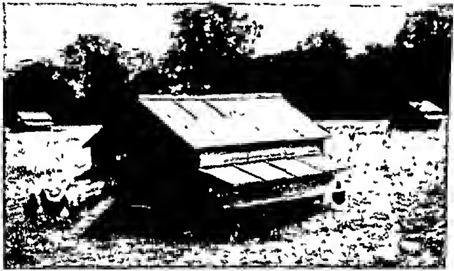

Photo Papworth Industries Cambridge

FIG. 207—THE SLATTED-FLOOR HOUSE

slatted-floor verandas to them. Grouped together near the farm buildings, they save much labour.

A convenient size for a house of this type is 6 × 8 ft., height from slats to eaves 3 ft., from slats to ridge 5 ft. The nests are built in on the "outside" principle, so that they do not overhang the floor, and there is usually a row of nests on either side of the house with an attendant's door at one end and "pop-hole" at the other.

Removable food-troughs are placed under the nests. Some models have a built-in water-trough. Nests, food and water are accessible from outside the house.

In front of the nests alighting-boards are provided. These

consist of two or three $\frac{3}{4} \times 2$-in. laths attached to suitable supports, hinged to fold over the nests to prevent the birds roosting in them at night. A broody coop may be built in, either on the outside of the house or inside at some convenient point.

There is a wide difference in constructional details of this kind, and opinions with regard to the most efficient lay-out are divided.

Lighting may be provided by windows in the end opposite the attendant's door or in the roof. Roof-lighting has received much support among poultry-men, and deservedly so, for it ensures more uniform distribution of light, and consequently absence of heavy shadows.

In slatted-floor houses this type of lighting is particularly suitable, because the better distribution of light encourages the birds to spread out evenly over the floor instead of congregating in groups, as they will do if they cannot see very well when going to roost.

In a house 6×8 ft. or thereabouts one roof-light 18×18 in., fixed immediately below the ridge-cap, will be adequate.

Slats are usually 1 in. wide at the top, 1 in. deep chamfered to $\frac{3}{4}$ in. wide at the bottom or $1\frac{1}{4}$ in. $\times$ $1\frac{1}{4}$ in., again chamfered towards the bottom. Chamfering prevents, or largely prevents, droppings adhering to the sides of the slats and eventually clogging them.

Slats should be about 1–$1\frac{1}{4}$ in. apart. Some houses are fitted with 2-in. $\times$ 1-in. slats (2 in. side horizontal) $1\frac{1}{2}$ in. apart.

Slatted floors must be supported adequately. They are usually built in two sections for ease of removal.

Wire floors are becoming increasingly common. They are usually of 3-in. $\times$ 1-in. mesh welded wire. Wire keeps cleaner than slats.

But whether slatted or wire floors are fitted, the general construction follows a common plan.

Ventilation is of the utmost importance in slatted-floor houses. It is often regarded as ideal. It should be so, but owing to faulty construction it may be far from ideal. In some houses the birds are exposed to draughts, in others circulation of air is so sluggish that the atmosphere becomes stuffy shortly after they have settled down for the night.

Two principles should be applied. First, with regard to floor ventilation, the sides of the house should extend 6 in.

below the level of the slats. This will have the effect of baffling the ventilation at this point, thus preventing the air blowing directly through the slats.

Droppings boards should be placed not less than 9 in. below the slatted floor, leaving a clearance of at least 3 in. on each of the four sides. The space between the sides of the house and the droppings boards should not be closed even in severe weather, therefore flaps should not be fitted.

The second point concerns the ridge ventilation. Here air should be extracted and there should be no possibility of down-draught.

In slatted-floor houses the birds roost on the slats. It is unnecessary to provide perches, although some poultry-men fit them, contending that the birds are more comfortable.

There is no evidence to show that perches serve any useful purpose in this type of house, or that the birds are healthier or lay better because of them.

Whereas in the solid-floor portable house it is usual to allow about 1½ sq. ft. of floor-space per bird, in slatted-floor houses half this area is sufficient.

A slatted floor 6 × 8 ft. will thus accommodate some sixty-five to seventy birds. The houses are made in many sizes, down to the 6 × 3 ft. layers' ark.

Where this type of housing is employed, food and water should be provided in the runs, the object being to encourage the birds to spend as much time as possible outside. To assist in ensuring full use of the land, the position of the food-troughs should be changed at frequent intervals. If the birds are fed always in the same spot, the ground at this point has undue wear at the expense of other parts of the run. That is bad management.

Semi-intensive Housing. In the semi-intensive house about 2–2½ sq. ft. of floor-space should be provided per bird. This is sufficient, because the birds are confined to the house only during bad weather.

The simplest type of house to build is one having a lean-to roof, but this type is not ideal, because it is more difficult to ventilate and is not so rigid as a full- or three-quarter-span roof. The full-span roof is by far the most efficient, and should be adopted wherever possible.

A house 12 ft wide and 20 ft long will hold about one hundred birds, one 12 × 12 ft up to sixty bird Houses of these dimensions are convenient for commercial purposes

Larger houses may be used, but it is then desirable to divide them into sections, each section containing not more than about 250 birds

When large flocks are kept semi intensively, it is difficult to keep the runs in good condition

There is a great variety of fronts suitable for houses for the semi intensive system

A simple design for a house having a lean to roof 7 ft high in front sloping to 5 ft at the back, is as follows The first 3 ft from the floor are boarded, and above are fitted windows 3 ft deep, these running in grooves and sliding down over the boarded section when required, thus leaving the upper part open The shutters are held up by chains, and are adjustable by looping in hooks in the framing of the house front under the roof The upper part is covered with 1 in mesh wire netting Above the window opening there is a space of about 6 in for ventilation It is covered with wire netting, and protected by a hood to prevent rain driving in

Another very simple type of front is one in which the windows slide horizontally This means that rather more than half the upper part of the front is boarded up, since the framework of the windows must overlap the boarded part to make the house weatherproof

The droppings boards should be placed at the back of the house, 2 ft from the floor, with the perches 6 in above them

Behind and beneath the droppings boards and 6-12 in from the floor, 2 × 1 ft floor lights should be fitted One light for each 10 or 12 ft run of the house will be sufficient These lights should not be fixed, but should open inwards and downwards into hoppers This will provide additional ventilation, indeed, these lights should not be closed day or night unless cold wind is driving on them

Ventilation A steady flow of fresh air entering the house beneath the droppings boards is of the greatest value, since it will prevent the accumulation of foul air about the perches

But adjustable floor lights will provide ample air intake, there is no need to have other inlets at this point

Immediately beneath the rear eaves a space of $\frac{1}{2}$ in. should be provided for ventilation, or a series of 1-in.-diameter holes should be drilled at this point. This ventilation should extend the full length of the house, and should be well baffled by a 4-in.-wide board fixed vertically outside the house $\frac{1}{2}$ in. from the back.

Although the lean-to roof is simple to construct, the full-span roof is preferable, for the reasons already stated. In

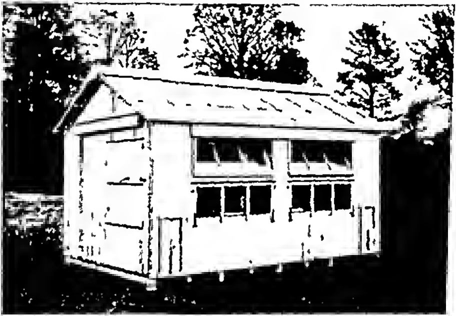

Photo Henry Hebditch Ltd., Martock, Somerset

FIG. 208.—A DOUBLE BREEDING-HOUSE

An excellent type of house for breeding purposes providing ample floor space. Note the lower shutters which open outwards and downwards

houses having this type of roof the ventilation is arranged on *different lines from that of the lean-to.*

Ventilation at the rear eaves is unnecessary, and in fact undesirable. Hopper-type windows in the front with floor lights in the back under the droppings boards can be relied upon to ensure an abundance of fresh air entering houses of this type, although there is no valid objection to providing front eaves ventilation, provided it is baffled.

Ridge ventilation can be by open ridge with horizontal cap or by a well-designed cowl.

In many semi-intensive houses nest boxes are placed along

the front under the windows, the top of the nests sloping upwards from front to rear and fitting under the window framing. Where the nests are so arranged small floor lights under them will avoid those dark spots that encourage floor laying.

Nests, which should be raised at least 18 in. from the floor, are frequently fitted on one side of the house, preferably on the side of the attendant's door. This will save a little time in egg collection.

The perches should be 2 × 2-in. battens, with the top corners slightly rounded. They should be placed 15 in. apart (from centre to centre); the rear perch should be 10 in. from the back of the house, the droppings boards extending for a similar distance beyond the front perch.

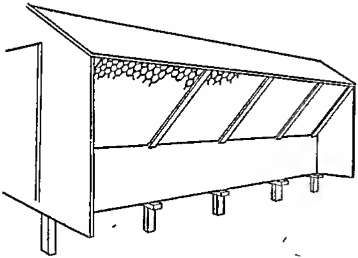

FIG. 209.—THE OPEN-FRONTED TYPE OF HOUSE SUITABLE FOR SHELTERED SITUATIONS

The water-trough housing may be built under the droppings boards. It may then be filled without carrying water into the house. In large houses the cost of laying on water from a main supply is fully justified. The water in the troughs may then be controlled by ball-tap or other device. This will result in a great saving of labour, so much so that it usually represents a very high return on the capital cost of a main supply.

If this system of watering cannot be adopted, a simple alternative consists of what may be described as a slatted table; that is to say, a stout framing 18 in. high, the top

having 1-in.-square slats fixed 1 in. apart. In the centre there should be a hole in which the ordinary 2-gall. bucket can stand.

The feeding-troughs are usually placed along the ends of the house or in the centre of the floor, but whether at the end or in the centre they should be raised 18 in. from the floor, with

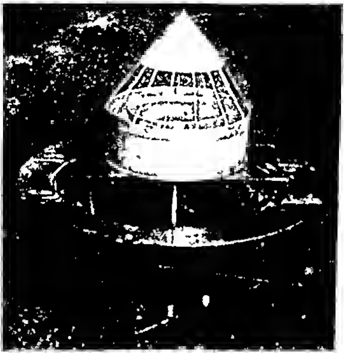

Photo: Thornber Bros. Ltd., Mytholmroyd, Yorks

FIG. 210.—A MODERN TYPE OF AUTOMATIC DRINKING FOUNTAIN IN USE IN AN INTENSIVE HOUSE

Water is gravity fed from a supply tank with ball-tap control. A pipe is connected to the drinker to carry off spilled water

of course suitable perches in front of them to enable the birds to feed in comfort.

Nest-boxes, food-troughs, perches and droppings boards should be easily removable to facilitate cleaning.

In all except exposed situations the open-fronted house with a deep hood to keep out driving rain is entirely satisfactory for the semi-intensive system.

A house with a front of this type should have a full-span roof. This is not essential, but most desirable. The front should be boarded-up some 2 ft. from the floor, the remainder of the

front being open Wire netting (1 in mesh) should cover the front from the outer edge of the hood to the top of the boarded up part, also vertically from the top framing to the boarded up part

Since the front is permanently open, no other ventilation is required, on the contrary, rear ventilation would create a through draught Additional ventilation is obtained by opening the floor lights under the perches at the back of the house

These houses provide excellent conditions for the stock As there is no rear opening, even during gales the air in the house acts as a cushion, thus preventing draughts

The design of the front prevents rain driving in at least to a serious extent, but snow may be troublesome To prevent this, arrangements should be made to fit canvas screens to the front In practice they are rarely needed, but they should be available This type of house is very suitable for use with a yard system

Deep-litter (Intensive) Houses The deep litter system is merely a development of the intensive system, the former enables the poultrymen to exploit more fully the advantages of the intensive system The only fundamental difference between the two systems as the terms intensive and deep litter are popularly understood—is that for the intensive system the houses are so designed to admit direct light, whereas for the deep litter system no direct light is normally provided the birds being dependent on dietary sources of vitamin D3

Intensive houses with two or three rows of shutters to give an almost completely open front are no longer favoured They have been replaced by deep litter houses which admit far less light, little or none being direct, many of which are lined wholly or in part to ensure more constant environment

Some houses now employed for the deep litter system are windowless They are fully insulated and equipped with power ventilation, all ventilators being constructed to exclude daylight

In these houses light patterns are followed to ensure maximum egg production irrespective of the season

Manufacturers have given much thought to the design and construction of houses suitable for the deep litter system Necessarily they are expensive compared with the cost of

adapting farm buildings, and if the latter are available their suitability for the purpose should be considered before capital is invested in specially built houses.

New permanent deep-litter houses may be built of wood, concrete, breeze or foam-slag blocks, brick or asbestos-cement sheets. Timber is most widely used. The houses are usually of one storey.

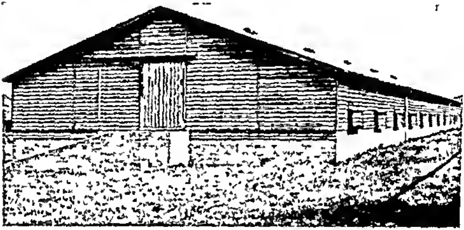

Photo: Vic Hallam Ltd., Langley Mill, Nottingham

FIG. 211.—A WINDOWLESS INTENSIVE BREEDING HOUSE, 157 FT. × 33 FT. AT THE NATIONAL INSTITUTE OF POULTRY HUSBANDRY, NEWPORT, SHROPSHIRE

Makers' prices do not include the floor, because this is usually of earth or concrete; nor do prices include foundations, erection, laying-on water and electricity unless specially quoted. The point is mentioned because this expenditure may be overlooked in estimating capital cost.

When specially built houses are erected they may be from 18–48 ft. wide; houses 18–24 ft. wide are probably the most popular numerically, but at present the general tendency is towards wider houses of 32–40 ft. or thereabouts.

Wider houses are rather cheaper per unit of floor area than narrow ones; they also permit of a more labour-saving lay-out than those long, narrow houses so long regarded as ideal for large flock units.

The house should stand on concrete or brick footings with supporting walls built up to about 18 in. above ground level. The walls should have a damp course, and the floor, of earth

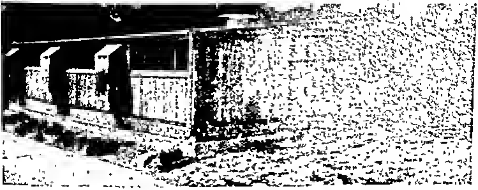

Photo: Neata Products (Cheltenham) Ltd.

FIG. 212.—A 30-FT. × 32-FT. 500-BIRD LAYING UNIT

This house has a double-skin aluminium roof and is lined throughout with Fibreglass and aluminium sheets. It is equipped with fan ventilation.

or concrete, should be constructed as already suggested in this chapter.

The larger deep-litter houses should have a wide door or a pair of doors, preferably of the sliding type (suspended by a track) in one or both ends. There should be provision for access by tractor to speed up the work of removing the litter. The doorway should have a concrete ramp.

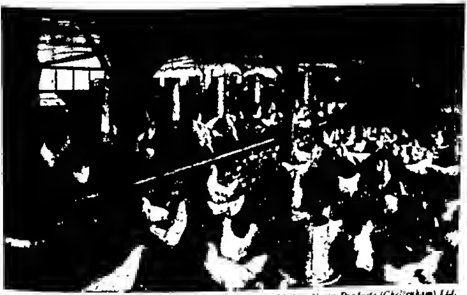

Photo: Neata Products (Cheltenham) Ltd.

FIG. 213.—INTERIOR OF THE HOUSE SHOWN IN FIG. 212

Droppings pit area, 25 ft. × 8 ft., is covered with slats. Tube feeders and automatic water troughs are mounted over the slats.

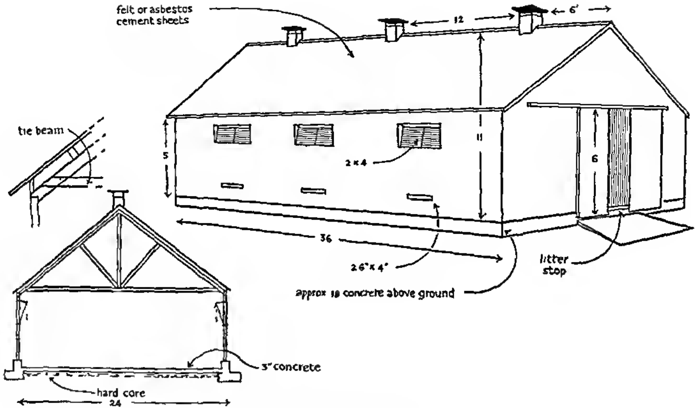

FIG 214 —DEEP-LITTER HOUSE

A type of house commonly used for the deep litter system The 2 ft 6 in × 4 in air inlets lead to shafts air entering the house under the windows

Deep-litter houses should not be more than 5 ft. high at eaves. Since they are mounted on walling, this will give ample head-room allowing for the usual depth of litter.

Windows may be of the vertical sliding type or the hopper type. The latter are the most popular, since there is no danger of rain driving in during an unexpected storm. Louvre-type windows are used in some houses, *i.e.*, sections of some of the windows are built on the principle of the venetian blind. They are, of course, adjustable.

If deep-litter houses are not completely lined with insulating material it will be found advantageous to line the roof, the greatest source of heat loss in winter and heat gain in summer.

Lay-out of Deep-litter Houses. The lay-out of deep-litter houses should be planned to save labour. Feed-troughs and nest-boxes should be placed in line, and perches should be so arranged that they do not entail a detour when attending to the birds. Every endeavour should be made to save unnecessary steps.

Water-troughs. Water should be laid on from the main or bulk-supply tank if main water is not available. Automatic water-troughs with ball tap, ball valve or other method of control are essential. Without an automatic supply, watering will prove extremely costly in labour.

Where a number of drinking-troughs are installed they may be fixed at precisely the same level; water can then be supplied from a common tank at the same level as the troughs, the tank being fitted with a ball tap.

In common with other fittings, drinking-troughs should be raised 1 ft. to 1 ft. 6 in. from the litter. Many troughs are readily adjustable for height; some are of the hanging type, being suspended by rope from the roof ties.

At one time it was desirable to have ball-tap and other types of drinking troughs with automatic control mounted over a wire or slatted frame with drainage below as a precaution against flooding.

With modern troughs of improved design, this is not necessary, since they are very reliable. Early teething troubles have been overcome.

In the smaller deep-litter houses the position of the drinker is not of major importance, provided it is easily accessible to

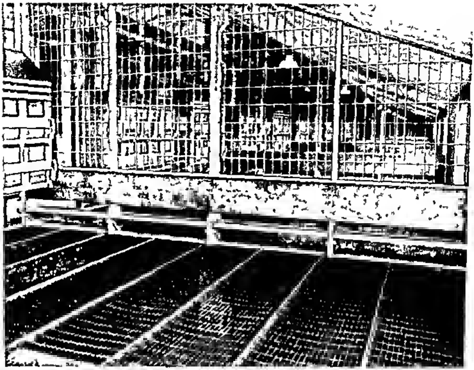

Photo Vic Hallam Ltd, Langley Mill, Nottingham

FIG. 215.—AN INTENSIVE BREEDING HOUSE WITH 3-IN. × 1-IN. "WELDMESH" WIRE FLOOR, BUILT-IN MASH TROUGHS AND TRAP-NESTS

The house, 157 ft × 33 ft, is divided into pens each 14 ft. square

the birds. In large houses drinkers should not be more than about 40 ft. apart.

Ample drinking-space should be provided. The allowances recommended on p. 345 are generous.

In insulated houses with the normal complement of birds there is little danger of the water freezing in the troughs; but should the houses be cold, it is advisable to take steps to keep the chill off the water during a spell of severe weather. This can be accomplished with small paraffin stoves or electric immersion heaters. Individual drinkers or the supply tank to the house may be heated.

Water-pipes leading into the houses should be lagged at all exposed points. It is also wise to lag tank overflow pipes.

Perches. Portable perches are commonly used. The type shown in Fig. 236 is satisfactory, although a series of perches

Photo Thornber Bros Ltd Mytholmroyd Yorks

FIG 216—A MODERN INTENSIVE BREEDING HOUSE

This is a section of a 240-ft × 34 ft house having four rows of pens with littered floors and two 5 ft wide passages Each pen 8 ft × 6 ft for fourteen fifteen birds is fitted with four nests with provision for trap nest fronts if required Eggs are collected from the passage Adjacent pens share a 5 ft long food trough which pulls out into the passage for filling The gravity feed drinking bowl serves two pens

mounted on a horizontal frame is more popular The latter usually have from four to six perches from 5 to 10 ft long

Very frequently perches attached to the feeding troughs provide sufficient perch space

If the litter is "working" properly it will absorb the night droppings, and the area under the perches will not resemble a manure dump Litter under the perches should be distributed from time to time in other parts of the house, or the perches should be moved occasionally during the winter months

In some districts and in some houses, however, droppings under the perches are not broken down They accumulate in a sodden mass

In these circumstances droppings pits are recommended They may be built against the back of the house as suggested

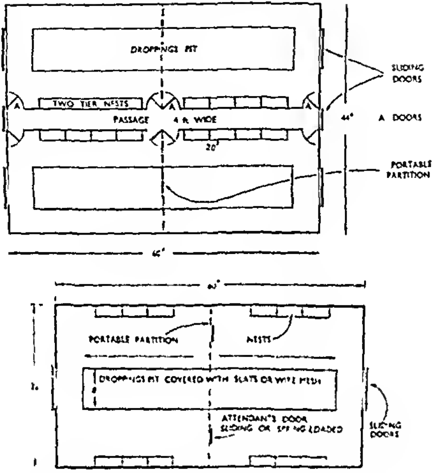

FIG. 217.—LAY-OUT OF DEEP-LITTER HOUSES

Two plans commonly adopted in commercial production. Both provide for the use of a tractor for removal of litter and droppings at the end of the season. Removable panels are preferable to sliding doors for entrances required only during cleaning operations. The former are cheaper and readily air sealed.

for strawyards. In some houses they are arranged along the centre, the ends of the pits consisting of removable sections to permit the manure to be removed with a tractor lift at the end of the season.

Slatted or wire roosts may be used instead of perches. They save space, because about ½ sq. ft. of slatted roost area per bird will be adequate.

In modern practice, however, roost area is much enlarged to provide space for feeding and watering. It may comprise approximately one-third of the floor area, the slatted (or wire)

section being in the centre of the house, with littered sections on each side.

Ratio of slatted: littered floor areas is by no means standardized. The greater the proportion of slatted floor, the greater can be the density of bird population—down to about 1 sq. ft. per bird for houses entirely without a littered section.

In some houses droppings are removed from the pits by

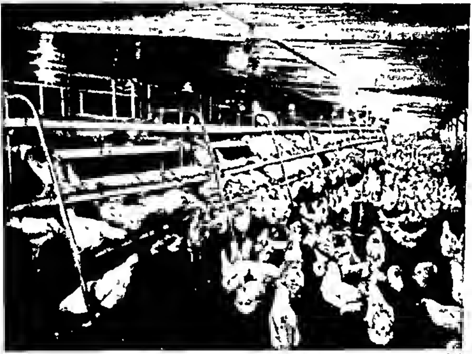

Photo Vesta Products (Cheltenham), Ltd

FIG. 218.—A 6,000-BIRD LAYING FLOCK IN A FULLY INSULATED, WINDOWLESS HOUSE WITH CONTROLLED LIGHTING, AUTOMATIC FEEDING, WATERING AND PIT CLEANING

mechanical scrapers with reciprocal action. The droppings are removed at frequent intervals.

Feed-troughs. If houses are not equipped with slatted or wire floor sections for roosting and feeding, feed-troughs should run parallel to the perches. In deep-litter houses they are usually supported about 1 ft. 6 in.–2 ft. from the floor, but they may be suspended at this height from the roof—a common practice in strawyards.

Hanging-tube feeders (about 35 lb. capacity) are suitable for deep-litter houses. They are used on many farms.

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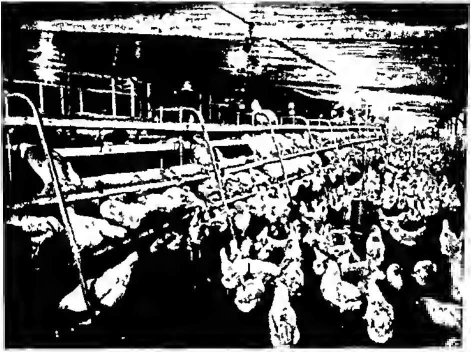

Photo Neata Products (Cheltenham), Ltd

FIG. 218.—A 6,000-BIRD LAYING FLOCK IN A FULLY INSULATED, WINDOWLESS HOUSE WITH CONTROLLED LIGHTING, AUTOMATIC FEEDING, WATERING AND PIT CLEANING

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Hanging-tube feeders (about 35 lb. capacity) are suitable for deep-litter houses. They are used on many farms.

Large houses frequently have a central passage with sections for laying stock on each side

With this lay-out nest-boxes, food and water troughs can be built into the partitions forming the passage, thus saving much labour in carrying out the daily chores

Nests, which can be of the roll-away type, are, of course, accessible for egg collection from the passage, as are the food troughs The latter may be of the large-capacity hopper type Nest sections can be fitted into grooves over the hoppers and pushed forward, *i e*, away from the passage, for filling the hoppers

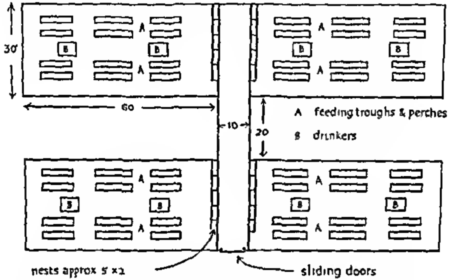


FIG 219—DEEP LITTER HOUSE ARRANGED ON THE "H" PLAN
The nests are of the communal type in two tiers Eggs are collected from the central passage

Nest-boxes Nest-boxes are usually of the communal type They should be placed along the side or across the end of the house, preferably in the latter position and near the attendant's door

On commercial deep litter plants houses are commonly built in pairs with a small room between the two houses Nests are built into the end walls Nest-boxes have shutters at the back, hence the eggs are collected from the central room, which is also used as a subsidiary food store The blocks of nests, in fact, provide the lower part of the end wall

Some large-scale producers adopt what is known as the "H" plan, *i e*, two pairs of houses are built in parallel with a central connecting room

Each house may accommodate from 200 to 500 birds. The distance between the houses should not be less than 20 ft. to avoid undue obstruction of light.

Broody Coops. Broody coops should be placed under, over or at the side of the range of nests to save walking time in dealing with the birds.

Coops should be divided into four sections: birds found broody on Monday should be placed in section A, sections B, C and D being used for each of the following days' broodies respectively. On the fourth day, birds in section A are released, and so the cycle continues.

Incidence of broodiness is extremely variable. As a rule it is advisable to provide broody-coop accommodation for about 10 per cent of the flock.

Broody hens, however, respond equally well to hormone treatment, and on many farms this method is now preferred to the more laborious one of confining them to coops. Reference to the effect of certain hormone compounds on broodiness will be found on p. 359.

Sun Balconies. In order to reduce the cost of housing or to make existing houses more suitable for intensive methods, sun balconies are frequently employed.

A balcony consists of a wire- or slatted-floor extension to the front of the house, raised about 18 in. from the ground, with sides and top covered with 1-in. mesh netting. It is usually as wide, or almost as wide, as the house or section, and extends 6 ft.–10 ft. from the house-front.

The balcony should be fitted with droppings boards or built over a concrete floor. Food-troughs should be fitted along the sides of the balcony, with a water-trough at the end. Access to the balcony should be provided by a wire door in the top.

It is desirable to fit wooden or hessian cloth shutters to the sides to provide protection against strong winds. If the shutters are hinged at the top framing of the balcony, shade can be provided in hot weather merely by folding the shutters over the wire top.

By the use of a balcony of suitable dimensions the number of birds housed may be increased by approximately one-third.

Wire and Slatted Floor Houses. Confinement of laying stock to houses having wire or slatted floors has been practised

for a great many years. Usually the units comprised small flocks rarely exceeding about 100 birds.

In recent times this system of housing has been applied to large flocks. Some deep-litter houses have been equipped with this type of floor, while houses especially constructed for the purpose are now available. In some cases the houses are of concrete, or Lignacite blocks and/or brick.

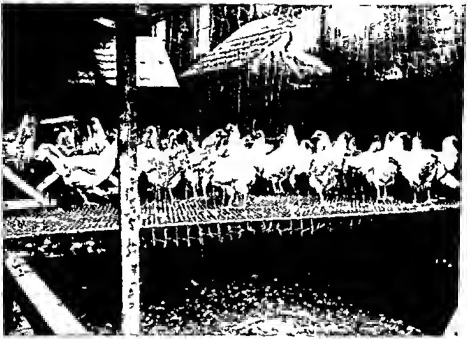


Photo The British Reinforced Concrete Engineering Co, Ltd, Stafford

FIG 220 —MANY LAYING FLOCKS ARE NOW HOUSED ON WIRE FLOORS

This floor is of "Weldmesh" Floors are usually built in sections 2 ft 6 in – 3 ft from the floor proper, which becomes a droppings pit

Wire floors are preferable to slats, since they are much cleaner and provide fewer hiding-places for insect pests.

Wire of 12 gauge, 3-in. × 1-in. mesh is commonly employed. Floors are built in sections, but there is a wide difference of opinion with regard to dimensions of sections and other details of construction. Some favour 12 ft. × 6 ft. or even larger sections, while others prefer sections of 5 ft. × 4 ft. or thereabouts.

Larger sections may be of 4-in. × 1½-in. framing with 6-in × 1½-in. bearers at about 3-ft. centres across the house; smaller sections may be of 3 in. × 2 in. supported by

6 in. × $1\frac{1}{2}$ in. bearers. Frames are usually cross braced at about 3-ft. centres.

Many floors are fitted with 2-in. × 2-in. perches at 18-in. centres laid on the wire, which may be supported by 5-in. × 2-in. bearers. Wire is attached to the perches, which thus give additional support to the floors.

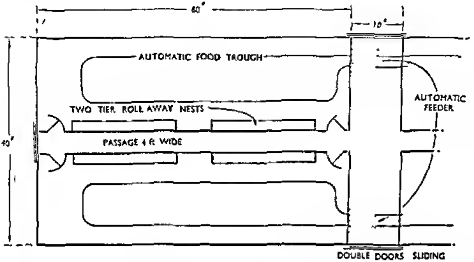


FIG. 221.—PLAN OF ALL-WIRE FLOOR HOUSE

Eggs are collected from the passage. Water troughs with valve control stand on the wire floors

Joists of 6 in. × $1\frac{1}{2}$ in. at 3-ft. centres will span 12 ft. without intermediate support.

Wire or slatted floors should be fitted not less than 2 ft. 6 in., preferably 3 ft., from the floor proper, which may be of earth or concrete.

This will provide ample space for manure voided during the year and ensure free circulation of air below the wire or slatted floors at all times. Inlet ventilation under the floors is unnecessary, since the normal ventilation system will avoid pockets' of foul air.

When adapting existing houses the matter of head room at the eaves should be considered. About 4 ft. should be regarded as minimum.

General lay-out of these houses should be on the lines of deep-litter houses. Large houses should have a central passage for egg collection and feeding. Roll-away nests are essential.

Some units are equipped with mechanical feeders operating from a central food store.

Since this system of housing permits stocking at the rate of 1 sq. ft. per bird, power ventilation and efficient insulation are essential. Roof should be double skinned, with insulation material between the skins. Walls should also be insulated unless they are of block or brick construction.

Power ventilation should be sufficient to provide up to about thirty-five changes per hour (see p. 578).

On some farms breeding stock is housed intensively on wire or slatted floors, either wholly on these floors or with a small littered section. Stock so housed give high fertility and hatchability, provided balanced breeders' diets are fed.

Fold Houses. *Broadly speaking, there are two types of* folds: the apex type, favoured by general farmers because it is not damaged by cattle, and the type that consists of a small, slatted-floor house with full-span roof. Both types are commonly employed, but the former should be used where it is intended to graze the land with cattle and run poultry over it at the same time.

Folds are of variable size, housing from twelve to fifteen birds up to about fifty. For commercial use folds 16–20 ft. long, 5 ft. wide are commonly employed.

Larger units are also available comprising a slatted-floor house about 10 ft. × 8 ft. with separate run sections 10 ft. × 8 ft., which are coupled together and with the house. With three run sections, eighty layers can be housed in these units, which are also suitable for breeding stock, including flock-mated pens. The units can be fitted with trap-nests. Smaller models following the same general plan are also in use. Multiple-section folds are moved by tractor.

Each fold is a self-contained unit. The roosting section has a slatted or sometimes a wire floor, nest-boxes and a broody-coop. Food-troughs may be fitted to this section, although they are usually placed in the run. The end section may be partially or entirely boarded up to give protection in bad weather.

The run is made of timber framing covered with 1-in. mesh netting with an opening at a convenient point to enable the attendant to enter the fold when necessary.

Drinking-water may be provided in troughs fitted in the

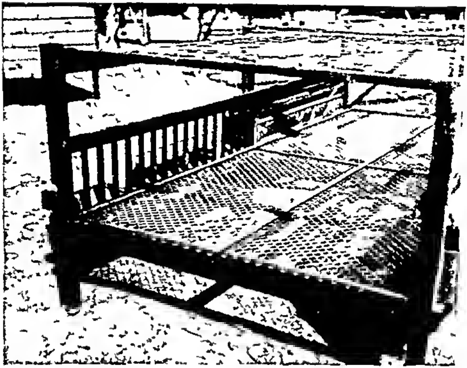


Photo Modern Poultry Keeping

FIG. 222.—SUN BALCONY

A portable sun balcony suitable for use with night arks or sections of large houses

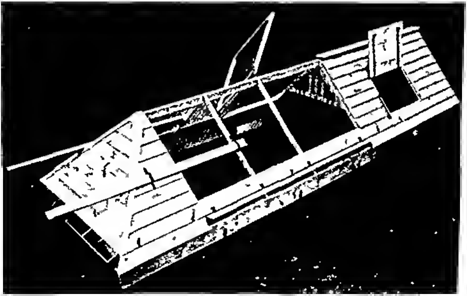


Photo Papworth Industries Cambridge

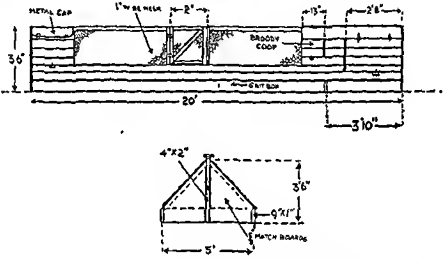
FIG 223 —A TYPE OF FOLD SUITABLE FOR GENERAL OR SPECIALIST FARM

It is readily moved by hand Trap nest fronts may be fitted to the nests The overall dimensions of the fold are 16 ft × 5 ft 6 in It is 3 ft 8 in to ridge

bottom framing in the side or end of the run, or by means of an ordinary 2-gal. bucket suspended by a chain from the top framing. This method is commonly used in the apex type of fold.

The floor should be of 1-in. chamfered (*i.e.*, tapered) slats 1 in. apart, and should be easily removable. Woven wire mats (1-in. mesh) may be used. A floor of 1-in.-mesh wire netting is not recommended because so many supports are required that it is difficult to keep the floor clean. Slatted floors are most commonly used.

The nests should be placed along one side of the roosting



S P B A Supplies Ltd, London

FIG. 224—CATTLE-PROOF TYPE OF FOLD UNIT

section. They should be lower than the slatted floor. This will encourage the birds to roost on the slats, not in the nests. Also, the nests need not be divided. A continuous nest-box—*i.e.*, one without partitions—is preferable; its construction is simple, it provides fewer cracks and crevices for the accumulation of dirt and fewer breeding-places for insect pests than the usual type of divided nest.

Wire netting is recommended for the floor of the nest. One-inch-mesh netting supported at intervals makes an excellent floor.

As a safeguard against egg-eating the upper part of the nest-front may be covered with hessian cloth (sacking) or similar material. In some folds a screen (metal, wood or hardboard)

about 2 ft. shorter than the nests is fitted in front of them, access to the nests is thus obtained from each end. In others, nests fitted with false floors are used to prevent this vice.

Broody coops are usually built in the folds, and are of the familiar slatted-floor construction.

Moving Fold Units. Fold units of the apex type are usually moved laterally. Moving is effected by a lever-and-sector arrangement, a pin in the lower part of the lever fitting into a socket in the vertical end supporting framework. But a strong man will do the job simply by placing a length of steel piping

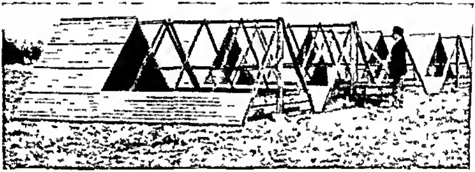


Photo: Poultry Farmer and Packer

FIG. 225.—MULTIPLE-UNIT FOLDS

Folds comprising 10-ft × 8 ft. houses with 10-ft. × 8 ft. run sections These folds are being used with one run section per unit, but additional sections can be added The sections are coupled together with sufficient play between them to avoid damage when moved over uneven ground. Folds are moved by tractor.

in the socket, lifting the end of the fold and carrying it over the width (5 ft.), repeating the procedure at the other end.

For moving lengthwise, the folds are mounted on wheels between the roost and run sections, where a balance is more or less effected. With handles at the end of the run, the unit can be moved with comparative ease.

Some folds are moved with a carrier device consisting of a pair of wheels mounted on shafts rather wider than the fold. The shafts are placed under the axle fitted to the fold at about the point of balance, the operator obtaining leverage with the ends of the shafts extending beyond the fold.

Large multiple-unit folds are mounted on skids, the end section having a loop of wire cable which engages a hook on the drawbar of the tractor. The hook is operated from the tractor.

To withstand constant moving, folding units must be soundly

constructed. If not built on substantial lines with well-made joints they depreciate very rapidly and are in need of frequent repair. On the other hand, if too substantially built the units are cumbersome and difficult to move. Obviously a middle course should be adopted.

Resin-bonded plywood is employed in the construction of a number of folds now on the market.

This material is light, strong and the best grades are very durable, but the common commercial plywoods are quite unsuitable for outdoor use.

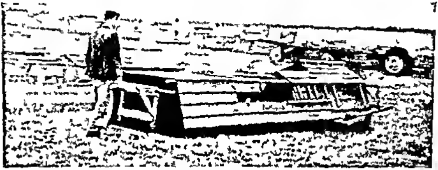


Photo Modern Poultry Keeping

FIG 226—FOR MOVING FOLDS LENGTHWISE WHEELS MOUNTED ON SHAFTS ARE COMMONLY USED

With the shafts under the axle the fold is raised from the ground, the shafts being kept in position as shown Portable moving handles are used at the other end of the fold

High-quality resin-bonded plywood is satisfactory if mounted on a firm framing. It will stand up to the wear and tear of everyday use Folds and brooders so constructed are easily moved, with or without the aid of a moving device.

Battery-housing. While outdoor batteries have proved successful under suitable conditions, the vast majority of commercial plants are housed. The advantages of housing are obvious. It must not be assumed, however, that batteries will be a success if operated in draughty buildings or places not adequately ventilated

The importance of ventilation in poultry-housing has already been stressed. In battery-housing it is paramount. It is no exaggeration to say that lack of ventilation—more rarely draught—has been responsible for more failures with this system than any other factor.

The general principles of ventilation have been discussed. In the battery-house it is essential that they should be fully applied.

Inlet ventilation, which should be controlled, may be arranged quite close to the floor in battery houses; in some houses air ducts are provided under the cage blocks.

Special provision for air inlets at or near floor level is not usually essential, however, because air entering through open windows will normally prove sufficient. It will circulate throughout the cage blocks.

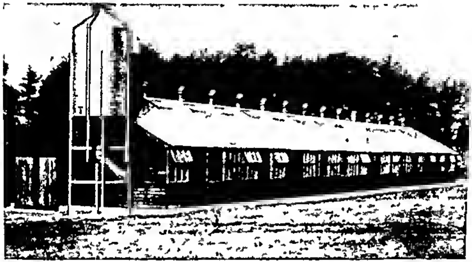


Photo Vic Hallam, Ltd., Langley Mill, Nottingham

FIG. 227.—A MODERN LAYING BATTERY HOUSE BUILT IN 8-FT. SECTIONS WITH SLIDING WINDOWS, THE TOP FRAME OPENING OUTWARDS

The house 96 ft long 9 ft to eaves is equipped with four tier cages arranged in three parallel blocks and exterior bulk storage bin with chute leading into the house

For commercial purposes batteries built in double blocks of three or four tiers are usually favoured. They may be placed at right angles to the front of the house or, more usually, parallel to it, with service passages on each side and between the blocks of cages.

As a rule two blocks of cages are placed down the length of the house. This means that three passages must be provided. The over-all width of cages placed back to back is approximately 4 ft. and, since the service passages should be at least 2 ft. 9 in. wide, the width of a house suitable for this lay-out

should not be less than 17 ft This should be regarded as the minimum, for there are few things more annoying than working in cramped surroundings It does not encourage efficiency

A minimum width of 17 ft relates, however, to batteries with static feeding With batteries of the cafeteria or travelling hopper type houses 18 ft wide are necessary for two blocks of cages, 24 ft wide for three blocks placed parallel to the length of the building

Cages in three tiers are about 6 ft high overall, in four tiers about 8 ft, therefore the house should not be less than 6 ft 6 in or 8 ft 6 in high respectively at eaves, with a 1 2 roof pitch An abundance of "top air" is essential

The width—*i e*, distance from side to side of the cage—is usually 14–15 in for single birds This may be regarded as the "standard" width, but cages as narrow as 10 in are available for smaller breeds and crosses, while two bird cages are usually 17–18 in wide Two bird cages of this width will house three or four birds

Assuming the standard 15 in cage in three double (back to-back) tiers is used and there are two blocks of cages in the house, every 15 in run of caging will comprise twelve cages

In calculating the length of house required for a given number of cages, however, allowance must be made for passages across each end of the house and between the blocks of cages Moreover, automatic cleaning and watering devices may increase the length of housing required Manufacturer s advice should be sought on this point

On some of the larger plants, especially those with mechanized batteries, the blocks of cages are arranged across the house *instead of parallel to its length*

House fronts The battery house should be designed to admit ample light It should, in fact, be "double fronted"—that is to say, the front and back of the house should be similarly constructed

A practical and simple plan consists of boarding up the first 3 ft from the floor, fitting above this a row of glazed shutters (2 ft high) to open outwards and downwards and above these a row of 12 in hopper lights

Another simple design consists of sliding shutters above the

boarded-up part, about 4 ft. wide and 3 ft. 6 in. high, covering, say, 3 ft. 6 in. × 3 ft. open sections of the front.

In some houses there are two, or perhaps three, rows of shutters. The only practical objection to a multiplicity of shutters is that additional work is entailed in opening and closing them. This may well represent a considerable sum in the course of twelve months on a large plant.

Coupling shutters would solve this problem. All shutters on one side of the house could then be adjusted with one lever or winding gear. This principle is widely adopted in greenhouses; it has been singularly neglected in poultry houses.

Roof. Insulation of the battery-house roof is advised. It will prevent extremes of temperature in winter and summer. Frost in the battery-house can cause much damage and loss of time, especially when the batteries are mechanized. Insulation is cheaper than artificial heating, although the latter may be necessary in very severe weather.

Insulation will assist in keeping the house cool in summer, and will thus help to maintain egg production during heat-wave conditions, when output tends to fall, at times severely.

Roof-lighting. Roof-lights are strongly recommended in laying battery-houses. Two lights about 2 ft. 6 in. × 1 ft. 4 in., placed on either side of the ridge in each 10-ft. section of the house, will provide adequate lighting. The length of the light should run from ridge towards the eaves, the top end being fitted beneath the ridge cap. These lights need not be made to open, but those facing the sun should be screened in hot weather. Birds in the top row of cages exposed to direct rays of the sun through roof lights suffer severely in hot weather; they may collapse from heat stroke unless shade is provided.

Sliding doors sufficiently wide to take a barrow or the farm's hand-truck should be fitted at each end of the house.

Windowless battery houses are now available which provide controlled environment. Many houses of conventional design have been adapted for this purpose, the windows being boarded-up and fan ventilation installed.

Battery-house Floors. Considerable difference of opinion exists regarding the most suitable floor for battery-houses—concrete or wood.

Concrete is cheap, rat-proof (if well made), sanitary, non-

began operations and the modern broiler house designed to provide ideal conditions

Broiler houses vary in width, but are usually between 30 and 50 ft , from 37 to 42 ft being most common

Length, of course, is related to broiler output Broiler houses are usually stocked at the rate of $\frac{3}{4}$–1 sq ft per bird, the birds being marketed when about seventy days old

Long-range broiler houses are usually divided into sections,

Photo Poultry Farmer and Packer

FIG 229 —A FOOD TROLLEY MOUNTED ON OVERHEAD TRACK IS REGARDED AS STANDARD EQUIPMENT BY MANY BROILER PRODUCERS

This trolley is being filled from a bulk storage bin with auger food conveyor

each housing from 2,500 to 5,000 birds. The smaller unit is generally preferred.

All modern broiler houses are fully insulated, having a *U* value from 0 2 to about 0 1. They are equipped with power ventilation, usually coupled to thermostats and time switches. Ventilation should provide about 6–8 cu. ft. air per bird per minute during the finishing stage, but about ½ cu ft. per minute will be adequate for baby chicks (see p. 578).

Broiler-house walls may be of 11-in. cavity brick (with the cavity sealed) hollow concrete, foam slag or Lignacite blocks,

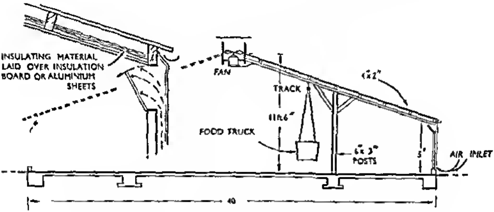


FIG 229A —SECTION OF BROILER HOUSE OF CONVENTIONAL CONSTRUCTION

timber or aluminium, the two latter being lined with insulation board or aluminium sheets, the cavity being filled with insulating material.

Prefabricated broiler houses are usually from 4 to 5 ft. high at eaves, but are intended to stand on plinth walls about 18 in. high Supporting walls should have a damp course. Porous materials used for external surfaces should be dressed with a water repellent.

Floor may be of concrete or well-rammed earth. Many houses have earth floors, but concrete is more satisfactory, because it can be thoroughly cleaned and sterilized between each broiler crop—an important factor in maintaining high-efficiency production

Roof is usually covered with asbestos-cement or aluminium sheets, with insulation board below and insulation material such as "Fibreglass" laid over the insulation board.

Very effective insulation is obtained by lining the roof with water-resistant plaster board or Sisalation Reflective Thermal Insulation sheets.

There are many methods of providing high insulation value; The above are mentioned merely by way of example.

Broiler-house framing is usually 3 in. × 1½ in. with about 3-in. × 3-in. posts and 6 in × 3 in. main rafters and 6 in. × 3 in. stanchions.

Methods of construction differ in detail. Some houses are designed to give a clear span, *i.e.*, without intermediate supporting posts between the walls.

Roof lining should follow the line of the roof; it should not be fitted horizontally at eaves level. Should roof height exceed 12 ft. at ridge a ceiling should be fitted at about 11–12 ft. from the floor. Very lofty buildings are undesirable, owing to the difficulty and cost of maintaining optimum temperature.

Inlet ventilation may be provided by hopper-type windows on each side of the house or in houses without windows by shutters at eaves level. Inlet ventilation independent of windows should be very effectively baffled on the Tobin-tube principle.

Baffles or shutters should direct the air at point of entry in a horizontal or slightly upward direction—never downwards, for this would tend to create floor draught.

If fans are fitted in cowl shafts they should be mounted in the lower end, where they are most readily accessible when they require attention.

Broiler houses should be equipped with food stores or bulk storage bins. The latter are becoming increasingly common. They enable food to be purchased in bulk without bags, thus effecting considerable economy.

Unless automatic feeders are installed a food trolley suspended from overhead track is essential, for without it feeding is a laborious and costly task.

Trolleys can be gravity fed from the bulk storage bins or filled by means of a mechanical auger.

Conversion of Farm Buildings. Many farm buildings may be adapted for poultry. Ventilation and lighting are the main problems associated with this work. Farmers wishing

to use barns, lofts, stables and so forth for poultry are advised to consult County Poultry Advisory Officers. Matters of this kind should be dealt with on the spot.

Houses Made of Felt and Netting. Poultry-houses built with roofing-felt and wire netting have been in use for many years, and, contrary to popular belief, they are durable, provided they are well constructed.

These houses can be made very cheaply by anyone capable

Photo Modern Poultry Keeping

FIG 230—THE INTERIOR OF A HOUSE BUILT OF ROOFING FELT AND WIRE NETTING

The perches are mounted over manure pits

of doing rough carpentry, and when the framing is erected the work is completed very quickly.

The house should be built in sections, and where a number of houses are to be erected the design should be standardized; then, if desired, larger houses may be made simply by inserting additional sections of sides and roof. Probably a lean-to roof will be preferred for small houses made of these materials, but a full span is recommended for the larger sizes.

A house 8 ft. or 10 ft. square, about 7 ft. high in front and 5 ft. 6 in. at the back, will be found a convenient size for the majority of farms.

The principal framing should be 2 × 2 in., with 2 × 1½-in.

supports so spaced that the edges of the felt with $1\frac{1}{2}$-in. overlap may be nailed to them.

Lighter framing is not advised, because if these houses are to have a long life it is essential that the framing shall not give unduly to pressure, and thus strain the covering, and possibly result in the felt being torn.

The framing must be perfectly square. It should be given a liberal dressing of creosote and set aside to dry before being covered.

Two-inch-mesh netting should be fixed to the framing. It should be tightly stretched to prevent sagging, well stapled and trimmed neatly at the edges, the end of the wire being turned in.

Good-quality three-ply felt should be used. It should be laid over the netting, the strips running from top to bottom. The felt should be unrolled and exposed to the weather for at least a week to prevent crinkling. It should be fastened with galvanized tacks, the overlap being sealed with special emulsion supplied by the makers. Some poultry-men dress the netting with a mixture of tar and pitch and while still tacky lay on the felt.

The roof may be constructed in orthodox fashion, or $2 \times \frac{1}{2}$-in. laths 12 in. apart may be attached to the rafters and the felt laid on them. The laths should be planed and the sharp edges rounded off to prevent chafing the felt.

The attendant's door should be of $\frac{5}{8}$-in. matchboards. The position of the door, pop-hole and windows should, of course, be decided before making the framing, for they are built into it.

Matchboards should be used for the trap-door and for that part of the house which the trap-door covers when it is open.

Ventilation should be provided on the usual lines, eaves ventilation in lean-to houses being protected by a deep hood to keep out driving rain.

Pole Barns. Barns built of rough poles are widely used for housing turkeys. They are equally suitable for rearing growing pullets or batches of table cockerels. On many farms so-called pole-barns built primarily for turkeys are utilized for pullets between the turkey "seasons".

Poles are usually of about 4 in. diameter. They may also be

used for the rafters Roofs may be covered with 2-in mesh wire netting overlaid with roofing felt with strands of galvanized wire 2 ft 6 in apart running from ridge to eaves A roof so constructed, however, deteriorates rapidly. Asbestos cement or aluminium sheets are better in the long run

Barns may have each side covered with wire netting, but usually one or two sides are clad at least partially with corrugated iron or asbestos-cement sheets to give the birds protection from wind

Food and water troughs may be placed along the front of the barn, the birds eating and drinking through a slatted or wire frame Portable perches complete the equipment

Barns of this type are littered with straw Floor is of earth

Straw (or Hay) Houses. This type of house can be built very cheaply. Such houses give all the protection the birds need and ensure good ventilation without draughts The cost of upkeep is negligible, and they will last for many years As they are not portable, care must be taken in the selection of the site with a view to economy in labour, while arrangements should be made to provide at least two runs for each house Very briefly, the houses are constructed as follows —

Stout poles are used for the framing. These should be well creosoted, and if possible the ends that are to be driven into the ground should be immersed in hot creosote, because this ensures deep penetration

Immersion in hot creosote is the best method, short of pressure creosoting, of preserving wooden posts, but the work should be done with care and away from buildings, owing to the risk of fire

Second-hand oil-drums are frequently used for this purpose These should be placed on bricks, with sufficient ground clearance for a small fire or oil stove to be placed beneath The poles should be placed in the drums, and the latter partially filled with creosote When the creosote is approaching boiling point remove the drum from the fire (or remove the stove) and allow it to cool with the poles still immersed. As cooling takes place creosote is drawn into the timber, thus securing good penetration

The poles should be about 3 in or 4 in in diameter, the length depending on the height of the house If a lean-to roof

is preferred, correspondingly shorter poles will be required for sides and back.

Mark out the site, and drive the poles firmly into the ground the length of two bricks apart if hay is to be used, three bricks for straw The bricks should remain between the poles to keep the packing material from contact with the ground

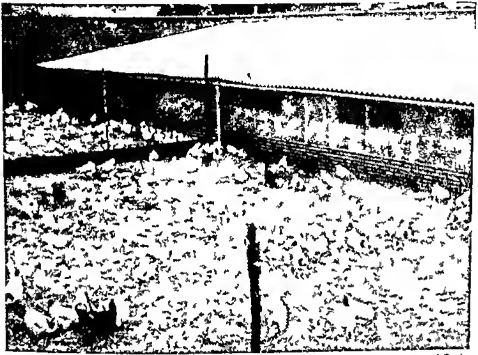


Photo Poultry Farmer and Packer

FIG 231 —STRAW-YARD HOUSING

The front of this house is made of straw between wire netting The wall is built up to about 4 ft from the ground, the remaining 2 ft of the front is covered with sacks some of which are turned back to the roof to provide open sections as shown The lower part of the front is covered with corrugated iron sheets the roof with asbestos cement sheets The house about 30 ft × 100 ft is divided into two sections It is used for breeding stock

When driven into the ground, cut off all poles at eaves level and cut to the required height the poles that will be under the windows Provision should be made for an attendant's door

One inch-mesh wire netting (this should be tarred in industrial districts) is now nailed to the outside and the inside of the poles, and as the rows of netting are fixed hay or straw is packed between them, thus forming a draught-proof wall

The inside wire should not be carried right up to the roof, a clearance of a few inches being provided at this point. This is necessary to enable additional hay or straw to be put in as the old material settles down. There should be no gap between walls and roof, but just sufficient clearance between inner wiring and roof for this purpose.

The roof should be made of wood and felt, straw thatch or corrugated iron. Spouting should be fitted, and there should be drainage to carry off the overflow.

The floor should be of rammed earth raised a few inches higher than the surrounding ground.

The lower part of the walls should be sprayed periodically with an effective insecticide, such as a mixture of creosote and sump oil.

To-day straw bales are used in the construction of many houses, shelters and hen-yards. When rough poles are readily obtained and straw is available, satisfactory houses may be made with straw thatch laid on substantial framing. Straw houses, especially those having a thatched or insulated roof, are warm in winter, cool in summer, and if properly ventilated they provide excellent conditions for the stock.

Insect pests may be troublesome in these houses, but no more so than in those built of timber. Spraying with a reliable insecticide will keep them free from red mites and fleas.

The Range Shelter. The value of the range shelter for growing stock has received belated recognition.

Prior to 1939 it was seen on comparatively few farms. The prejudice against it may perhaps have arisen because it was frequently described as a summer range shelter, whereas in fact it is suitable for use at all seasons.

In recent years the advantages of the shelter have been more widely recognized, and some manufacturers are now producing houses of this type some of which may be readily adapted for laying stock.

A properly constructed range shelter solves the problems of ventilation and crowding, because even if more chicks crowd into a shelter than it will comfortably hold, its construction is such that the birds have an abundance of fresh air.

Range shelters are cheaper than arks, and young stock do well in them, even during the winter months, provided the

birds are not moved from the brooder or carry-on brooder house until they are well feathered.

A shelter 6 × 8 ft. will house about eighty growers. Smaller shelters may be built if desired, but those larger than about 6 × 8 ft. are rather cumbersome. The larger the shelter the greater the tendency for the poultry-man not to move it. This is a practical point that should not be overlooked.

Shelters may be described as a series of covered perches over wire or slatted floors. They are usually about 2 ft. 6 in. high

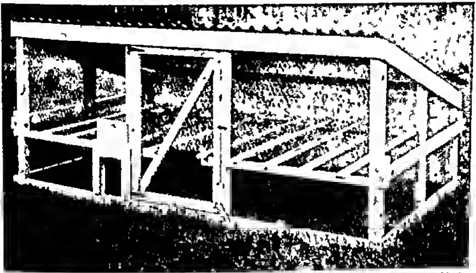


Photo Thornber Bros., Ltd., Mytholmroyd, Yorks

FIG. 232.—A LEAN-TO SHELTER OF SIMPLE DESIGN
Roof and back can be covered with corrugated-iron sheeting

at the eaves, rising to about 4 ft. at the ridge, the roof overhanging the eaves by at least 12 in., preferably 18 in. The uprights may be 2 in. × 1½ in., the framing 2 in. × 1 in. with 4-in. × 1-in. boards forming the base.

To the cross-pieces at eaves level, rows of 2-in. × 2-in. perches running lengthways should be fitted. There should be two or three rows of perches on each side, with a passage in the centre. The two centre perches should project to form handles.

The framing should be covered with 1-in.-mesh netting with a door at one end.

The roof may be covered with netting and roofing felt on 2-in. × 1-in. battens 12 in. apart, resin-bonded plywood or galvanized iron sheets.

In this type of shelter a wire floor is recommended It should be 1-in mesh 16 gauge, made in sections and suitably supported A 5- or 6-in board in the centre of the floor will prevent damage to the wire when the attendant enters

Shelters of many different types are now available, the modern tendency being to provide more protection than formerly by covering two or perhaps three sides with, of course, provision for under-floor ventilation

Wire or slatted floors have replaced perches in many of the shelters now being marketed

Some of the larger shelters are mounted on skids and are intended to be moved by tractor These shelters may be about 10 ft × 9 ft and will house about 125–150 pullets to point of lay and even laying stock if detachable nests are fitted to them

Wire mesh (3 in × 1 in) floors with 2-in × 2-in perches placed directly on the wire is now a popular form of floor construction Pull out feeding troughs may be fitted along each side

Many shelters are of triangular section, the roof extending almost to ground level In these shelters floors are usually about 9 in from the ground

End sections are usually covered with 1-in mesh wire netting or welded mesh wire with an attendant's door in one end and a pop hole in the other The pop hole should be about 2 ft square

End sections may be covered or partially covered for a time when pullets are moved to the shelters in inclement winter weather

Small lean to type shelters are also popular They are usually about 8 ft long, 4 ft wide, 3 ft 6 in high in front, about 2 ft 3 in high at the back Roof and back may be clad with corrugated iron Sides and front are covered with wire netting, the front having an attendant's door

On each side of the door five perches are fitted about 15 in from the ground Perches 2 in × 1 in are placed 5 in apart

Framing usually consists of 2-in × 2 in vertical and 2-in × 1-in horizontal members with a 4-in × 1-in fascia board

A shelter of the above dimensions will house about fifty pullets to point of lay

Convertible Range Shelter A type of range shelter suitable for

growing and adult birds has been designed by the National Institute of Poultry Husbandry.

The shelter now in use at the Institute is lighter than the original type, and can be easily moved by two people. It is capable of housing fifty growing pullets to maturity, groups of stock cockerels, laying pullets or breeding hens between seasons.

The following constructional details are taken from the specification:—

"The overall size is 8 ft. × 6 ft. × 5 ft. high. The framework throughout is 2 in. × $1\frac{1}{4}$ in., of sectional construction and

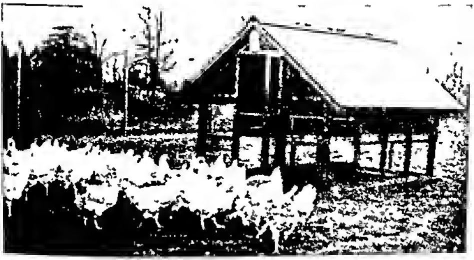


FIG. 233.—RANGE SHELTER

Controllable type of range shelter designed by the National Institute of Poultry Husbandry It will house 50 growing pullets to maturity. Nests can be fitted if the shelter is required for laying stock.

secured by bolts. The whole is bolted on two 3 in. × 2 in. skids. The skids are fitted with four light tow rings, but it is not intended to be towed over long distances. For long moves it can easily be loaded on to a tractor trailer by two men.

"Several types of roofing material have been used as follows: (1) Narrow width $\frac{5}{8}$ in. rebated weatherboard (as a standard); (2) Wire netting, felt and thatch; (3) Ordinary hardboard treated with 3 coats of bituminous mastic; (4) 'Masonite Prestwood' treated with 'Aquaseal'; (5) 'Tempered Masonite' untreated.

"The roof construction is standard for all materials and has been specially designed to suit an 8 ft. × 4 ft. sheet. The roof sections are bolted to the end walls, and wooden ties nailed at the apex of the rafters as shown. The feet of the rafters are fastened to the side walls by light twisted metal ties. The ridge is flush fitting to protect the edges of the hardboard and

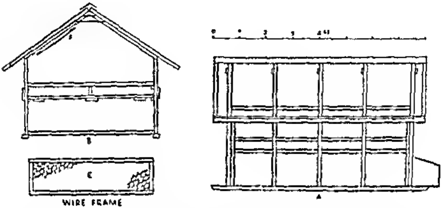


FIG. 234.—CONVERTIBLE RANGE SHELTER

A, Side elevation B, Cross section E, Wire frame fits under droppings board to facilitate catching the birds and to prevent their going underneath when first housed Stored in roof in position F when not in use.

is not intended to provide ventilation. The gable ends of the hardboard sheets are protected by a rebated cloaking strip.

"The rear of the shelter is covered with hardboard with a small air vent left at the apex. Two flaps are fitted to allow for cleaning the droppings boards and for the removal of the slatted floor. One of these flaps has been made smaller than the other so that a catching crate can be placed against it. If hinged, both flaps should open downwards, alternatively they may be buttoned top and bottom.

"Under the flaps is a wire-covered frame which may be replaced by an outside nest box if needed. This nest should rest on the overhang of the 3 in. × 2 in. skids and should preferably be made without divisions.

"Timber may be saved by dispensing with the droppings boards (reducing the cost approx. 30s.). In this case the slats should be stouter than 1½ in. × 1 in. as the droppings boards support the weight of the birds. This is done by

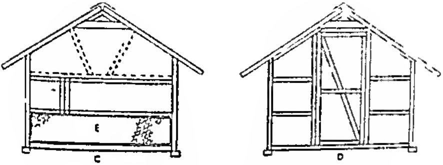


FIG. 235—RANGE SHELTER
C, End section D, Door end section E, Removable frame Nest fits in here.

"For easy removal the droppings boards should be made in one piece.

"The hinged flaps on the side of the shelter are intended to give ventilation between the droppings boards and slatted floor. If made in three sections on each side they give a certain control over ventilation, though at no time can they be completely closed as there is always a space between the wire netting on the inside of the framework and the flaps on the outside.

"The diagonal braces shown in dotted lines on the end section were found necessary to prevent wracking of the framework."

The Catching Crate. Catching crates are usually about 4 ft. by 2 ft. 6 in., but the width should be less than that of the doors of the houses so that they may be taken into them. They should be about 20–24 in. from floor to top. Each end should be fitted with a lifting shutter, so that by placing the crates in line and removing all shutters except the end one in the last crate, several may be filled at the same time.

The floors should be solid, the sides of 1 in. mesh netting,

account should they be fixed, because it is necessary to remove them when cleaning the droppings boards and for periodical inspection for red mites.

An alternative plan consists of mounting double perches on $4 \times 1\frac{1}{2}$-in. battens. Each pair of perches can then be lifted from the droppings boards or turned back against the rear of the house when the boards are cleaned.

For light breeds 8 in. of perch space per bird should be provided; for heavy breeds 9–10 in. These are generous allowances.

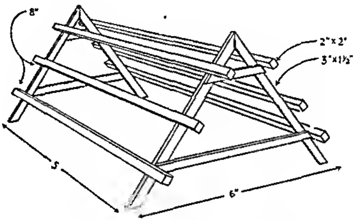


FIG. 236—PORTABLE PERCHES OF THIS TYPE ARE FREQUENTLY USED IN DEEP-LITTER HOUSES

At one time it was recommended that perches should be arranged at the same level, to prevent the birds crowding on the top perch. To-day, when larger flocks are kept in straw yards, it is a common practice to have a series of perches sloping upwards towards the back of the house, the perches being mounted over manure pits. This is done to induce the birds to fill up the higher perches before the lower are occupied, but of course some individuals have their own ideas about the best place for sleeping.

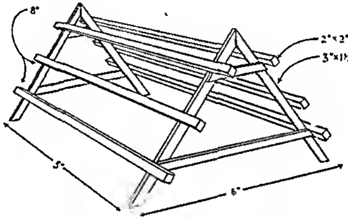
When this method is adopted 3-in.-mesh netting should be used beneath the perches to prevent the birds scratching among the droppings.

Wire and Slatted Roosts. In deep-litter houses it is now more usual to mount the perches horizontally over droppings pits or to cover the pits with wire or slatted frames. The

account should they be fixed, because it is necessary to remove them when cleaning the droppings boards and for periodical inspection for red mites.

An alternative plan consists of mounting double perches on 4 × 1½-in. battens. Each pair of perches can then be lifted from the droppings boards or turned back against the rear of the house when the boards are cleaned.

For light breeds 8 in. of perch space per bird should be provided; for heavy breeds 9–10 in. These are generous allowances.



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Wire and Slatted Roosts. In deep-litter houses it is now more usual to mount the perches horizontally over droppings pits or to cover the pits with wire or slatted frames. The

latter plan is most commonly adopted, because the area over the droppings pit then serves the triple role of roost, feeding and watering places.

Portable perches are still in use on some farms, but most poultrymen with deep-litter units prefer to equip them with dropping pits, placed centrally in the larger houses to facilitate manure removal by tractor.

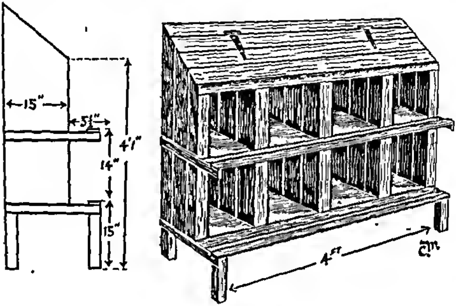


FIG. 237.—SET OF NEST-BOXES

Even in small houses of the semi-intensive and range type slatted or wire frames frequently replace perches. Frames, whether of slats or wire, should provide about ¾ sq. ft. roosting space per bird.

Nest-boxes. The usual type of nest-box is 15 in. deep (front to back), about 14 in. high, and 12 in. wide, with a 2½ × ½-in. strip fixed across the front of the floor to keep in the litter. They are usually built in single or double tiers of four or six nests per tier.

Nest-boxes should be raised at least 18 in. from the floor, with a 2 × ¾-in. alighting-perch about 4 in. from the front of the nests.

Nests should not face the light. They should be placed along the front of the house facing inwards or across the end section—*i.e.*, at right angles to the front.

Photo Modern Poultry Keeping

FIG 238—COMMUNAL NEST-BOXES IN A DEEP-LITTER HOUSE

The birds enter the nests at the back The small shutters in front ensure speedy collection of eggs Note depth of nests

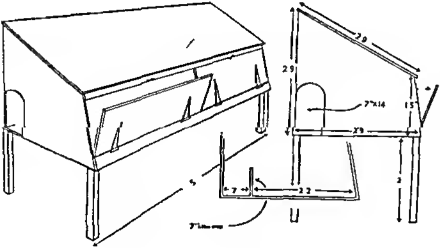


FIG 239—DIMENSIONS IN TYPE OF NEST-BOX SHOWN IN FIG 238

One open nest-box should be provided for every five hens; when trap-nests are required, one nest for every three hens.

Where trap-nesting is undertaken it will be found convenient to build the nests in two tiers, with a hinged top sloping 45° from back to front. The top may then be used for storing the eggs until they are collected in the late afternoon, and the trap-nest record card can be pinned to the under-side of the lid.

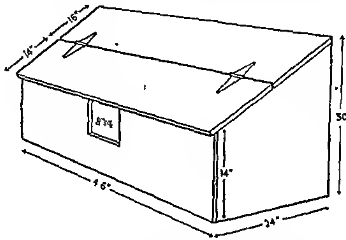


FIG. 240.—A COMMUNAL NEST-BOX
It should be placed on a shelf and against the wall of the house which form the floor and back of the nest.

Communal Nest-boxes. Where trap-nesting is not undertaken, communal nest-boxes have much to recommend them. They prevent birds crowding in one nest, and are easier to keep clean and of course simpler to construct.

But they are by no means universally popular. Some producers using the deep-litter or yard system for comparatively large flocks prefer the individual nest, maintaining that unless eggs are removed frequently from communal nests there is greater risk of breakages than with the divided nest.

The writer has used both types of nest, and favours the communal type. When egg production is high it is wise to collect the eggs at fairly frequent intervals, otherwise there is risk of breakages with both types.

The communal nest has no partitions, and with this exception may be constructed on the same lines as the orthodox nest. On some farms, however, nest-boxes of this type are made

much deeper than usual, and may be 2 ft. or more from front to back.

They are not open fronted—*i.e.*, they have only an entrance -exit and a passage along the back. Ventilation is adequate because they are set away from the wall of the house. The dark conditions reduce egg-eating.

Many nests of this type have 1-in. wire mesh-netting floors, littered with hay or straw. Wire floors reduce losses from broken eggs, and are more sanitary than solid-floor nests.

Some favour using strong paper (paper meal bags) over the wire netting and then littering the nest with sawdust.

A very popular type of communal nest is that having an 8 in. × 8 in. entrance in the centre (Fig. 240).

This nest may have a wire or wooden floor, and the latter may be in the form of a shelf, the bottomless nest-box being placed on it, and against the wall which forms the back of the nest. Some put the nests on the floor in straw-yard houses, but in normal circumstances it is better to keep the floor of the house as free from obstruction as possible. The communal nest or section thereof should not exceed 5 ft. in length. A nest 5 ft. × 2 ft. will provide sufficient accommodation for about sixty birds.

If the enclosed communal nest does not appeal—some assert that it induces broodiness—the open-fronted nest with 7 in. clearance for entry between the hinged lid and litter board will be found an effective substitute. The framing may be covered with hardboard.

Roll-away Nests. Nests in which the eggs roll away from the birds have been in use for many years. They are installed in some deep-litter units; they are essential for the all-wire or slatted-floor system of housing layers in confinement. Further reference to this type of nest will be found on p. 758.

Watering Devices. An abundance of clean drinking-water is essential for the maintenance of health and production. It should be cool in summer, and if possible the chill should be taken off it in winter or, failing this, steps must be taken to prevent the water freezing.

The provision of drinking-water may be laborious and costly, especially on large poultry-farms. Every endeavour should be made to reduce the cost to the minimum.

Water should be laid on to all large houses to convenient points on the rearing ground, and so far as practicable to the smaller houses, such as single-sire breeding pens

A piped water supply is readily provided by plastic tubing The cheaper kinds have not a long life and do not stand up to the rough treatment as do the superior grades Nevertheless, they are useful for carrying water to stock on range and for many purposes where first cost must be kept as low as possible

Superior-quality tubing is, however, the cheapest in the long run Alkathene is a well-known product in this class It is extremely tough, well suited for both temporary and permanent installations It can be laid underground, an operation that can be carried out very quickly by fixing the tubing to a mole drainer, which will pull it through the soil

If the farm has not a main water supply arrangements should be made to supply well water by gravity Larger houses should be fitted with guttering and water butts or tanks to collect rain-water for augmenting the normal source of supply

In long houses the water vessels may be built into housing and arranged on the outside principle The water level may then be controlled by a ball-tap fitted to the supply tank If piped water is not available, this arrangement will at least avoid carrying water into the house, which is never entirely satisfactory, because of spilling

Drinking-troughs mounted outside the house are readily warmed by small paraffin stoves, or even electric immersion heaters, and where the water supply is controlled by a ball-tap there is no danger of flooding should the latter get out of order

In modern deep litter housing practice, however, water is now almost invariably supplied in the house, *i e*, not on the outside principle, by drinking-troughs with automatic control by ball-tap, nipple or spring-loaded valve

Some favour continuous flow channel-iron drinkers of the type frequently employed in broiler houses These drinkers should be mounted over a grille for drainage

Troughs are of many different types, some are simply open troughs, preferably with grid over to prevent fouling of water

Ball-taps are frequently built into them, but the taps can be

fitted to the supply pipe The trough is then readily removed for cleaning

To-day it is customary to carry main water to tanks (with ball taps) in the houses Low-pressure water supply is thus provided by the tanks to automatic drinkers

Circular and cup type drinkers are widely employed They may be mounted in series along the supply pipe or even fitted to drums or barrels for watering birds on range

During recent years drinkers fitted with spring loaded two-way action "Fox" valves have become popular They are of two types, the trough type, which is usually mounted on a stand on which the height is adjustable, but may be suspended

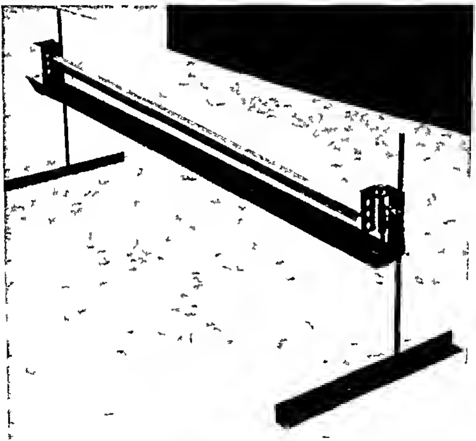


Photo Keata Products (Cheltenham) Ltd.

FIG 241A —A DRINKER WITH A TWO-WAY ACTION, SPRING LOADED "FOX" VALVE

The valve closes automatically when the trough is removed

from the roof, and the circular, hanging type, the height being adjustable by chain or rope

The valve controls the height of the water in the trough as it is taken from it, and the supply is automatically cut off when the trough is removed for cleaning

Photo Vegla Products (Cheltenham) Ltd

FIG 241B — A TUBE-TYPE HANGING DRINKER FITTED WITH TWO WAY ACTION VALVE

In brooder-houses conical "top fill" vessels are commonly used, but, whatever type is favoured, they should be raised from the floor after the chicks are a few days old This is essential, to prevent the water being fouled with litter and droppings

For watering birds on range, earthenware troughs with sides sloping outwards are very popular, because they are easily cleaned, and their shape is a safeguard against damage caused by the water freezing

Galvanized-metal containers with vertical sides are most unsuitable for outdoor use during frosty weather. Unless the water is prevented from freezing, great damage may be done to them in the course of a few hours.

Small pig-troughs will be found very useful for water.

For stock kept on free range, water laid on at convenient

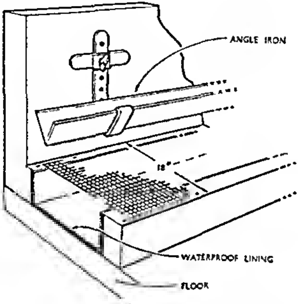


FIG. 242.—SECTION OF A CONTINUOUS-FLOW 2-IN. ANGLE-IRON WATERTROUGH OF THE TYPE FREQUENTLY EMPLOYED IN BROILER HOUSES

Height of the trough is adjustable

points will save much labour, and if a large trough or tank is provided under the stand-pipe, time will be saved in filling buckets. Stand-pipes should be insulated against frost.

At the National Institute of Poultry Husbandry an automatic and portable watering system is used on the rearing-ground. The water-troughs are fitted with ball-taps connected to the main with plastic hose-pipes of sufficient length to enable the troughs to be rotated through 360°, and thus to prevent waterlogging and foul patches developing on the pasture. The troughs are emptied at night in frosty weather, and provision is made for the drainage of the supply pipes to which the hoses are connected.

Where the semi-intensive system is adopted—as, for example,

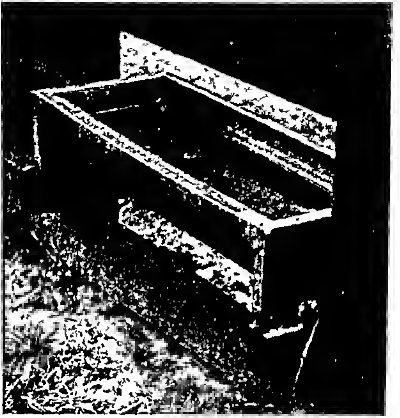


Photo Modern Poultry Keeping

FIG 243—A WATER-TROUGH MOUNTED IN THE BOARDED-UP PART OF THE FENCING

The attendant can water the birds without entering the run.

in the breeding-pen section of the farm—it will be found convenient to place the water outside the runs; the troughs may then be filled by the attendant without his having to enter the pens.

Food-troughs. Food-troughs of every conceivable shape, size and type are found on poultry-farms. Their efficiency is equally variable; some are satisfactory, but others are difficult to keep clean, and many cause waste of food.

For wet-mash feeding the simplest type of trough consists of two 6-in. boards nailed together to form a V section and mounted at each end on 1 × 6-in. boards of sufficient length to prevent the trough being upset.

Although this type is the simplest, it is not efficient. The birds stand on the mash, contaminating it with their drop-

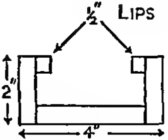


FIG. 244.—MASH HOPPER SUITABLE FOR CHICKS UP TO ABOUT ONE WEEK OLD

pings, and a considerable proportion of the food is pecked over the side and trampled underfoot.

These defects may be overcome by fitting 1-in. lips to the trough and a hinged grid, the bars being about 2½ in. apart. The grid should be triangular in section, so that the birds cannot stand on it and foul the mash.

A useful type of trough suitable for wet- or dry-mash feeding consists of a trough 8 in. wide, 5 or 6 in. deep, with a spinner bar over the centre to prevent the birds standing on the food. One-inch lips on either side of the trough will save waste of food.

Yet another type suitable for dry- or wet-mash feeding, although more commonly used for the former, is a V-section trough (with spinner bar) mounted on supports about 2 ft. from the floor.

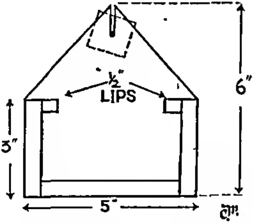


FIG. 245.—SECTION OF MASH HOPPER SUITABLE FOR CHICKS FROM ONE TO FIVE WEEKS OLD

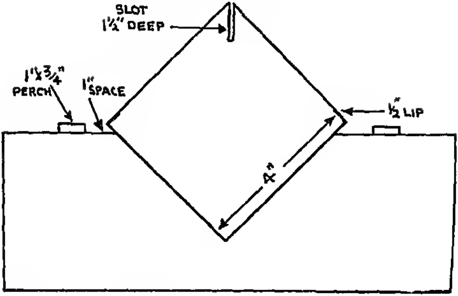


FIG. 246—HOPPER SUITABLE FOR CHICKS FROM ABOUT FIVE TO TEN WEEKS OLD

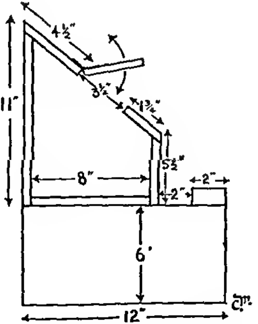


FIG 247—DRY-MASH HOPPER

For dry-mash feeding so-called self-feed hoppers are commonly used. Many are unsatisfactory because the hopper is wider at the top than at the bottom; consequently the mash clogs, and the trough itself may be empty while the hopper above it is almost full. Some hoppers alleged to be of the non-clog design require the services of an attendant to unclog them every few hours. The sides of self-feed hoppers should be vertical, or even a little wider at the base than at the top. The trough should be fitted with a lip to prevent waste.

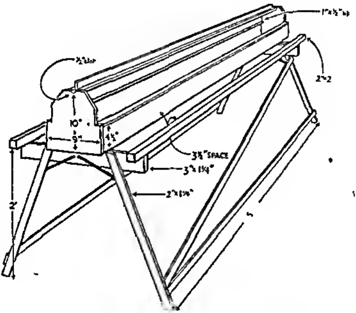


FIG. 248.—A FEEDING-TROUGH SUITABLE FOR THE DEEP-LITTER SYSTEM

A popular type of trough for the deep-litter system is shown in Fig. 248.

Recently, hanging (tube) feeders have become popular for all classes of stock. They are suspended by cords from the roof of the house. The height is readily adjustable. They are usually of metal, but feeders made of plastic are now available. The clearance between the bottom of the tube and the pan must be carefully adjusted, otherwise either the birds will be underfed or there will be great wastage.

In some tube feeders mash tends to clog, especially when it contains additional fat to provide a high-energy diet.

Pellets and crumbs always flow more freely than mash in self-feed or hopper type of troughs For mash feeding the tubes should taper slightly outwards towards the pan

For outdoor dry-mash feeding the hopper should be in a

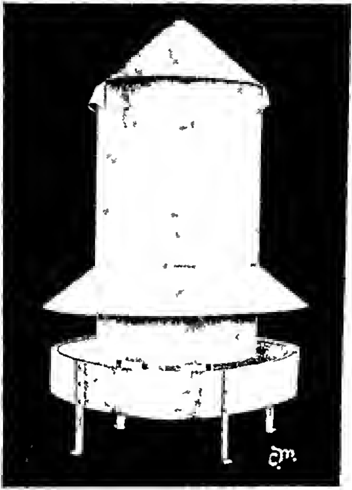


FIG 249—OUTDOOR DRY-MASH HOPPER

sheltered spot and the trough well protected by a hood On some farms small portable shelters are employed Failing these, a few hurdles will be found very useful, particularly in exposed situations In wet, windy weather food consumption, and therefore production, may be seriously affected unless the birds are able to feed in comfort

Automatic Feeders In large flock-houses, in which the

birds are kept in total confinement, long feeding-troughs in which the food is supplied automatically are used on some farms These are employed to reduce labour costs and to provide continuous fresh mash

These troughs may extend the full length of the building At one end, which should be in a separate section of the house, the dry mash is fed automatically into the trough, and is carried

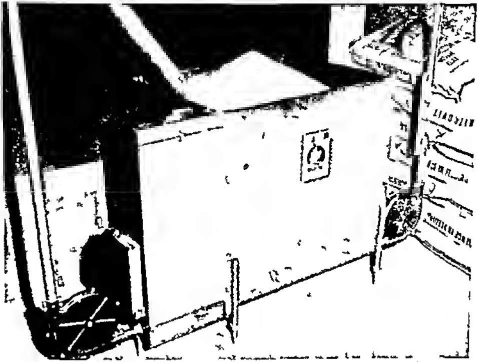


Photo Maywick Appliances Ltd W kford Essex

FIG 249A —THE FOOD BIN OF A MECHANICAL FEEDER
Conveyor tube leading to feed troughs is seen on the left

along it by a power-driven chain The latter is continuous Operated *intermittently* by *time* switch control the chain is carried round corners by pulleys in the trough Surplus food is returned to the supply hopper

One type of automatic feeder employs a reciprocating metal trough, so designed that it carries the food along the entire length of the feeder

Another type of mechanical feeder which can be used in broiler, deep litter and battery cages fills troughs and tube feeders and can even be used to serve several houses

This feeder, known as the "Poultry Chef", conveys food from a bulk-storage hopper through a totally enclosed tube fitted with a special linkage conveyor operated electrically.

The main conveyor tube is overhead, and the feeders are gravity fed by tubes leading from it.

The conveyor tube can also be utilized for filling the conventional battery or floor troughs directly.

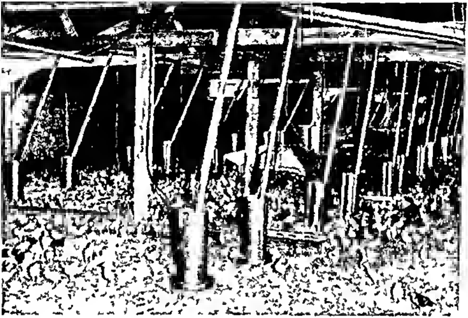


Photo Maywick Appliances Ltd., Wickford Essex

FIG 249B—THE ENCLOSED TUBE TYPE OF MECHANICAL FEEDER IN USE IN A 36,000-BIRD BROILER HOUSE

The main conveyor tube is overhead

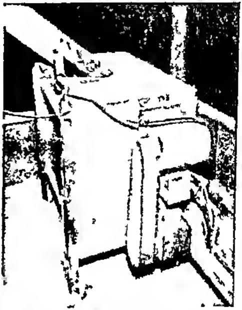
This feeder is controlled by time switch, which is pre-set according to the number and age of the birds.

Laying-battery Cages. For commercial work laying-battery cages are usually built in 3 or 4 tiers, with the cages back to back. Each block usually contains about 204–408 cages, but there may be many more.

In cages fitted with a mechanical cleaning device for the removal of droppings the number of cages per block must be limited to the capacity of the device. This applies particularly to the scraper type of cleaner, because if too many cages are grouped together, the volume of droppings will block the scraper as it approaches the end of the droppings boards In

order to overcome this difficulty when unusually long lengths of cages are installed, a gap is provided between them at suitable intervals Droppings pans are placed in the gap or the droppings fall into pits

Cages built in blocks of one and two tiers are available also in tiers of five or more



Photos C pe & Cope Ltd Read ng

FIG 250 (*left*) —AN AUTOMATIC FEEDER EMPLOYING THE CONTINUOUS CHAIN PRINCIPLE

Food is conveyed along the trough by an agitator chain operated by a power unit on the master bin Chain is carried round corners by pulleys mounted in the troughs Height of the latter is adjustable

FIG 251 —THE MASTER FOOD BIN AND POWER UNIT WHICH IS CONTROLLED BY TIME SWITCH FOR INTERMITTENT PERIODS OF FEEDING

Amount of food conveyed in the troughs can be adjusted by a device fitted to the bin

The manually operated battery—*i e*, one in which all the work of feeding, cleaning and watering is done by the operator —was the first type of battery to be placed on the market, and despite the mechanization of later models this type is not without its supporters

Systems of Watering The modern, unmechanised battery however, has one of the many watering devices with a view to saving labour Individual drinkers of the early batteries are no longer favoured The drinkers may consist of troughs running the full length of each block of cages, the level of water

in the troughs being controlled by a hand-operated or ball-tap. The troughs may be mounted over the feed-troughs or at the back of the cage—*i.e.*, between the two rows of cages.

Some cages have a tippler tank watering device. This consists of a pivoted tank fitted in a larger tank to which hose-pipes are attached which carry the water to the troughs.

A tap over the tippler tank is adjusted to give the required volume of water in a given time. When the water rises to a certain level, the weight of water in one end of the tank un-

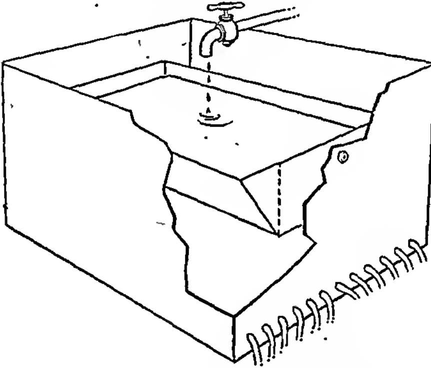


FIG. 252.—THE TIPPLER TANK WATERING SYSTEM

balances it, and the water falls into the outer tank, and so to the battery troughs. The tippler tank then reverts to its horizontal position. Theoretically this results in complete flushing of the drinking-troughs, but in practice occasional cleaning of the latter is necessary.

The syphon system of watering is employed by some makers. The supply tank, mounted on top of the block of cages, slowly fills from the main. When full, the water is syphoned from the tank to the drinking-troughs.

In other batteries the drip system of watering is employed.

A supply pipe is fixed along the top of the block of cages, and taps are fitted at intervals to correspond with the cage divisions.

Stout wires extend from the taps to an overflow trough connected with a drain. At a point convenient for the bird the wire is bent, and the bird drinks the drops of water as they leave the wire. Surplus water drops on to the wire below the loop, and thus provides for the bird in the centre cage. The same method is adopted for the bottom cage.

It may be thought that this system results in great waste of water. This, however, is not so, provided the tap at the top of each wire is set to ensure an adequate but not excessive flow.

The overhead-valve watering system is suitable for batteries. It consists of a low-pressure gravity-fed valve operated by the birds. The valves are fitted to pipes between the two rows of cages, the water supply being controlled by a ball-tap in a tank to maintain the correct pressure.

If the water is clean, the valves, which are rust proof, do not clog, and of course no water-troughs are required, thus saving labour in cleaning.

Cleaning Systems. Many power- and hand-operated devices for the removal of the droppings are now available. Some employ scrapers running in wood or metal, trough-shaped droppings trays extending the full length of the battery, some an endless belt, or others a wire belt with tarred paper over it. As the wire belt is wound by pulleys, the droppings fall into a box placed at the end of the cages. When a length of paper has been drawn through the battery, the paper is torn off, droppings and paper going to the manure-heap.

This is often described as the toilet-roll system. Unfortunately, some birds peck holes in the paper which with the netting forms the ceiling of their cage, but, despite this, the method is practical and very hygienic.

Many manufacturers use ¼-in. plate glass for the droppings trays which are cleaned by a scraper.

Cafeteria Batteries. The fully mechanized or cafeteria battery in which food- and water-troughs move along the cages and the droppings are continuously removed has become popular in recent years. Many ingenious devices are to be found in batteries of this type; it must not be assumed,

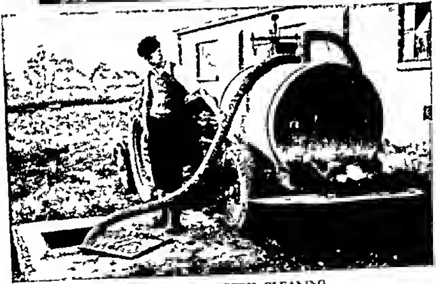


FIG 253.—BATTERY CLEANING

(*Above*) On some battery plants equipped with plough scrapers the droppings channel at the end of the blocks of cages is cleaned by flushing with water

(*Below*) The liquid manure passes through a drain into a pit adjacent to the battery house The manure is pumped from the pit into a liquid manure spreader.

however, that they will necessarily result in more economic egg production—the principal objective of the commercial producer.

Nevertheless, cafeteria batteries undoubtedly effect economy in labour. The greatest snag is the possibility of mechanical breakdown or power failure, which may occur at a most inconvenient time.

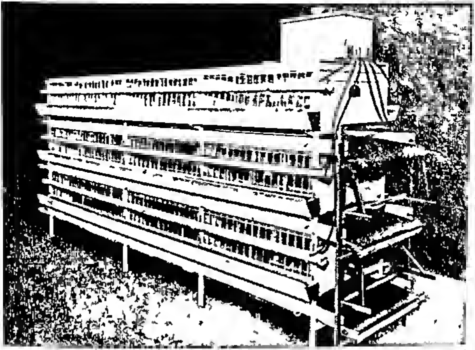


Photo John Shepherd & Sons Ltd Blackpool

FIG. 254.—A BLOCK OF SIX-BIRD CAGES, EACH CAGE BEING $31\frac{1}{2}$ IN. LONG

These cages are fitted with a tippler tank watering system and paper cleaning Feeding is by hand

Some method of speedy watering and removal of the droppings is recommended not only to save labour, but also to make battery management more attractive. Some operators, however, prefer single droppings trays because the condition of the droppings of individual birds is more easily noticed—an important point when culling—and single trays require less frequent cleaning than batteries equipped with scrapers. Further to reduce labour the droppings can fall into channels at the end of the cage blocks, from which they may be water flushed into a brick or concrete pit adjacent to the building.

Alternatively, droppings may be removed by scraper mechanism set at right angles to the cage blocks, the scrapers carrying the manure out of the house to the manure cart at the end of the scraper track

The most modern battery feeding system consists of power- or hand-operated hoppers mounted in framing that runs on a track the full length of the cages

Food falls from the hoppers into the troughs as the hoppers pass along them The amount of food can be adjusted by altering the flow from the hoppers In some models small troughs, in a continuous metal strip, form the feeders In these models food can fall from the hopper only when it is over the troughs, when not over the trough the metal strip cuts off the flow

The travelling-hopper mechanism is coupled with the droppings board scrapers—hence cleaning and feeding are carried out in one operation, usually once daily The batteries are fitted with continuous water troughs

Different methods of water control are used—tap, tippler or syphon systems

Batteries fitted with travelling hoppers have become very popular Portable power units are supplied They are, of course, used for a number of blocks of cages Gearing can be hand turned in the event of a power failure or breakdown of the unit The majority of batteries, however, have built-in power units, and in some models scrapers and hopper carriage can be controlled independently, although normally operating together

Batteries with automatic hopper filling of troughs are now most widely employed They have largely replaced the cafeteria models

Multi-bird Batteries Prior to the late war a number of battery-owners found that it was possible to keep two birds in a cage originally designed for one Owing to the high cost of battery equipment, there has recently been a revival of this system, and some manufacturers are now producing twin-bird cages providing rather more room than the single-bird type. The original 15-in cage will, however, be found adequate for two birds

Before adopting the "doubling-up" process the battery

operator should satisfy himself that two birds can eat and drink in comfort, and that the house is sufficiently well ventilated for the greater density of the population

The economy of the twin-bird system is obvious, since the capital cost per bird of the equipment is approximately half that of the single-bird cage Today the practice of keeping two and three birds per cage is quite common Excellent egg-production records have been obtained with this system, indeed, in some cases the production has been higher than from single-bird cages

In recent years cages designed for up to twelve birds have been introduced, in fact, the cages have adjustable partitions which will provide one cage 63 in long for 10–12 birds, two cages $31\frac{1}{2}$ in long for 5 6 birds and so on down to a $12\frac{3}{5}$-in cage for one bird or a $10\frac{1}{8}$-in cage for one light hybrid pullet Cages of this type are of the usual width, *i e*, 17–18 in from front to back

The disadvantages of multi-bird cages are the greater difficulty in culling and risk of cannibalism Culling in these cages calls for skill in handling and observation, particularly the latter If the batteryman has this attribute he can expect to get high egg yields, if he is not so skilled he will get a better return from single- or twin-bird cages

Clearly the risk of cannibalism is considerable Debeaking is the best remedy Some debeak the birds as they are placed in the cages, others debeak only when trouble arises

Outdoor Cages Although outdoor cages have proved a success, it cannot be said that they have become popular for commercial purposes They provide little control of environment, as a result egg production may slump severely during a spell of exceptionally hot or cold weather They are more suitable for countries having a more equable climate

Moreover, the outdoor system does not make a strong appeal to the man in charge of the birds, since attending to them in bitter, wintry weather is not a pleasant job, whereas in the battery-house he can work under comfortable conditions at all times of the year

A well designed outdoor cage is a useful proposition for the small poultry-keeper, and in certain circumstances for those operating on a larger scale, but for all round commercial

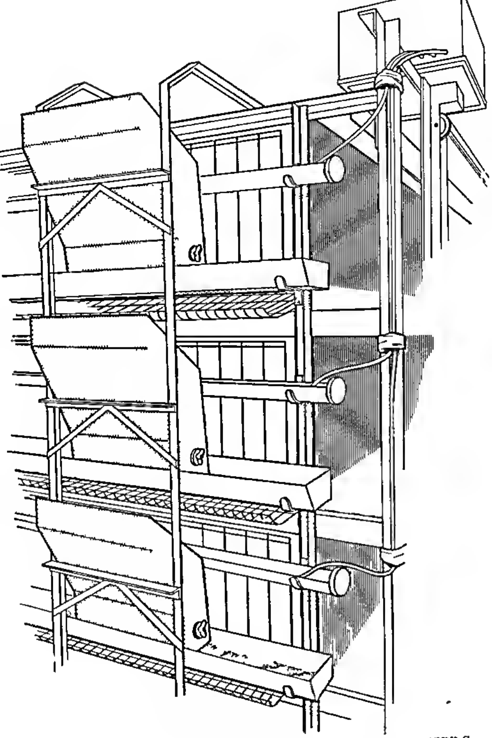


FIG 255 —LAYING BATTERY WITH AUTOMATIC HOPPER FEEDING
(See opposite page)

purposes the indoor cage is preferable. The work can then proceed with the smoothness of a factory operation

Battery cages are of all-metal or wood-and-metal construction. Whether the former is superior to the latter or vice versa is controversial. Both have their advantages and disadvantages, and the kind selected is a matter of personal preference. Whether the cages are built entirely of metal, or of metal and wood, they must be substantially constructed to withstand normal wear and tear.

In some cages on the market the metal is of the lightest gauge and the timber not sufficiently strong for the purpose, consequently depreciation is rapid.

When investing in batteries, those obviously built to sell at the lowest possible price should be avoided. It pays to spend a little more for a battery that will give years of efficient service.

Subject to this proviso, the design of the cage is of far more importance than the material used in its construction. Many wholly unsatisfactory cages have been put on the market largely because of makers' lack of experience, but even to-day it would appear that certain firms do not hesitate to use their customers' farms for experimental purposes.

Dimensions. The dimensions of cages vary somewhat. Usually "single" bird cages are 14 or 15 in. wide—*i.e.*, from side to side—17 in. from front to back, 18 in. high in front, 14 in. at the back, the floor sloping 4 in. in 17 in. The floor should project at least 6 in. from the front of the cage proper, making an overall depth of 2 ft. or 4 ft. for a double block.

A point of some importance is that the clearance between

Side panels may be of 2 × ¾ in wire mesh or sheet metal Cages are usually about 17 in from front to back, the "standard" cage being about 14½ in wide Floor may be of 13 gauge 2 in × 1-in mesh and should slope 4 in in the depth of the cage proper. Height of cage from sloping floor is usually 14 in at back, 18 in at front Floor should project 6–8 in from front of cage Droppings trays should be about 5 in below cage floor in front

Bob wires in front of cage should be 2½ in apart Drinking troughs may be of galvanised or vitreous enamelled steel or plastic material They are commonly 2½ in round with a 2-in opening

Clearance between top of cage (or bob wire framing) and top of drinker should be about 3 in, that between drinker and food trough about 5 in Food trough may be 4 in deep against cage, 4 in wide and about 5 in deep in front A 1-in lip should be fitted, preferably with an additional ¼ in turning downwards towards the food

Clearance between bottom of food trough at front of cage proper and wire floor should not exceed 2¼ in

the front of the cage and the wire floor should not exceed $2\frac{1}{4}$ in. This is ample clearance for the egg to pass to the front of the floor. If more is provided it tends to encourage egg-eating.

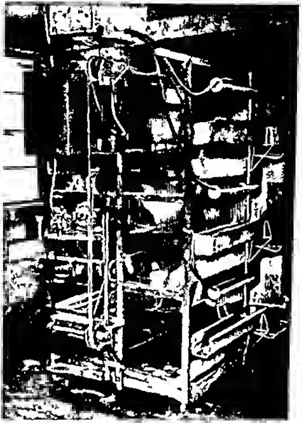


Photo Poultry Farmer and Packer

FIG. 255A.—THE POWER UNIT OF A BATTERY WITH AUTOMATIC FEEDING

The motor seen at the end of the centre tier of cages is coupled to both the food carrier (*right*) and the scrapers, some models provide independent control of carrier and scrapers They can be disconnected by moving a lever

Droppings trays or boards should be fitted about 5 in. below the floor, at the point where it projects beyond the cage front, 9 in. at the back.

Battery-cage Floors. There are many types of floor. Care should be taken to avoid those made of too light material that sags, and those in which the mesh is so fine that droppings clog them.

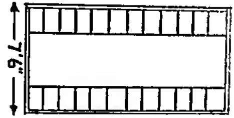


FIG. 256.—LAY-OUT OF LAYING BATTERY-HOUSE

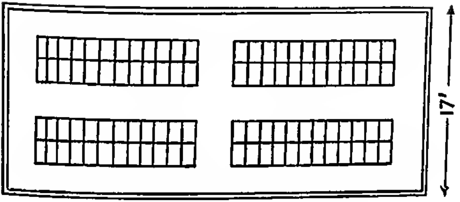


FIG. 257.—LAY-OUT OF BATTERY-HOUSE

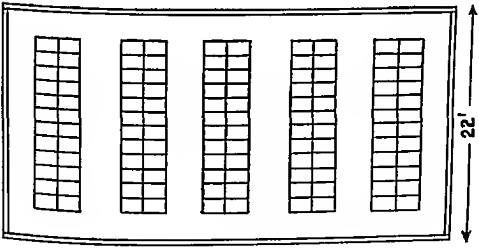


FIG 258—LAY-OUT OF BATTERY-HOUSE

Ordinary galvanized wire netting of 1-in. mesh and 16 gauge makes a satisfactory floor that keeps reasonably clean and wears well. The wire should be tightly stretched over $1\frac{1}{2}$-in. × 1-in. framing resting on cross-bearers at the back and front of the cage.

Woven wire mats are used in the majority of cages now marketed. Fourteen-gauge 1-in.-mesh crimped wire is very suitable. It does not sag, yet has that springiness which makes the floor comfortable for the birds, and, incidentally, reduces the loss from cracked or broken eggs.

A floor that has become very popular in recent years is one made of spot-welded wire 2-in. × 1-in. mesh, the top wires running from back to front of the cage. These floors keep very clean, and there is little danger of the eggs failing to roll to the front.

That some floors are not well made is readily apparent by rubbing the hand over them. Rough edges and small projections on the wires are often responsible for broken or cracked eggs and foot troubles. Although the roughness wears off in time, it is wise to examine new floors.

Cage-fronts. Most cages have wire fronts suspended by hooks from the top framing and opening inwards and upwards. The wires (commonly called "bob" wires) should be $2\frac{1}{2}$ in. apart, and should extend a little below the top of the hopper. In cafeteria batteries the bob wires usually rest against wire or sheet metal which provide sufficient clearance for the eggs to roll to the front of the floor, but not sufficient for the bird to get out of the cage or to eat the eggs. There should be an adequate clearance between the mash-trough and front of floor, to ensure the speedy collection of eggs. Much time may be lost and many eggs broken if the attendant is compelled to use finger and thumb to pick up the eggs. The loss of time, too, is annoying, and causes dissatisfaction among conscientious workers.

Partitions. There is divergence of opinion with regard to wire or solid-sided partitions. The former give better distribution of light, which is beneficial in houses not well lit; on the contrary, some claim better egg production, better feather condition and less feather-plucking in solid-sided cages.

Whether wire or solid pratitions are used they must fit well, because should there be gaps between them feather-plucking is inevitable.

All partitions and floors should be removable for cleaning.

The Food Store. Anyone securing possession of a holding having a good barn or other building that may be used as a food store is indeed fortunate. Proper facilities for storing

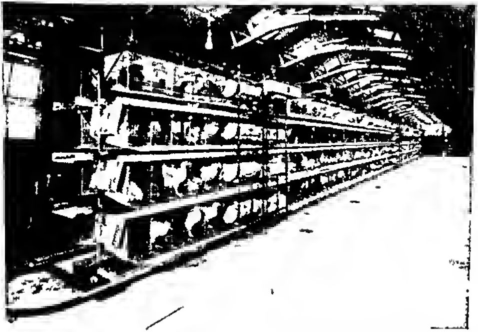


Photo D McMaster (Bures) Ltd, Suffolk

FIG. 259—A FULLY MECHANIZED LAYING BATTERY EMPLOYING THE CAFETERIA SYSTEM OF FEEDING AND AUTOMATIC WATERING SYSTEM

foodstuffs are essential, and if a suitable building is not available, one must be erected. This will mean capital expenditure that is not directly productive.

A weather-proof, rat-proof building of ample size for the farm will save much waste of food and enable foodstuffs to be purchased in large quantities, and therefore at a reduced price. Buying in small lots is always a costly procedure, but it is inadvisable to store meal for more than two months, although grain will keep much longer under good conditions.

If a food store must be built it should be of brick if possible, and should have a concrete floor with a smooth surface and

rat-proof footings. Failing brick, concrete blocks, corrugated iron or asbestos cement sheets are the most suitable, since they are rat-proof.

Whether iron or cement is used, the sheets should be carried well below the surface of the ground to keep out vermin, and all ventilators should be vermin proof. Rats and mice frequently find their way into the buildings at the eaves, and therefore precautionary measures should be taken at this point also.

Hinged doors with metal sheeting nailed across the bottom are preferable to the sliding type, the latter being difficult to make rat-proof.

Food stored in bags should be placed on slatted frames, which should also be fitted to the walls to ensure free circulation of air. In no circumstances should the bags be placed on a concrete floor, for condensation results in the meal getting damp and mouldy at the bottom.

It is more satisfactory to use bins than keep the food in bags. The latter can then be emptied and returned to the carter at the time of delivery. A new consignment should not be placed on top of the old—hence the need for an abundance of bin-room.

In a rat-proof food store wooden bins are recommended. The front should be made up of loose boards sliding in grooves, the boards being removed as the food is used. This will save time and much back-bending.

On some of the larger farms provision is made for the bulk delivery of feeding-stuffs. The feeding-stuffs are brought to the farm in lorries with bulk-feed hoppers, usually of 5–7 tons capacity.

A delivery pipe connects the hopper with the inlet direct to the bulk-feed store, the food being conveyed from hopper to store by pneumatic pressure provided by a power-driven compressor on the lorry. Pressure is sufficient to lift the food to the upper storeys of the granary.

This method of delivery saves time; it also obviates the use of bags, and is therefore an additional precaution against the possible spread of disease.

If mashes are mixed at home a power-operated mixer will prove a good investment. Mixers are made in a great variety

of types and capacities, and no difficulty will be found in obtaining one that will deal effectively with the work.

If ready-mixed mashes are purchased and stored in bins, each bin should be clearly marked to show the kind of mash it contains. This is a safeguard against feeding the wrong mash to the stock. This error is by no means unknown, and it may have serious consequences.

Fencing. Galvanized wire netting of 2-in. mesh and 19

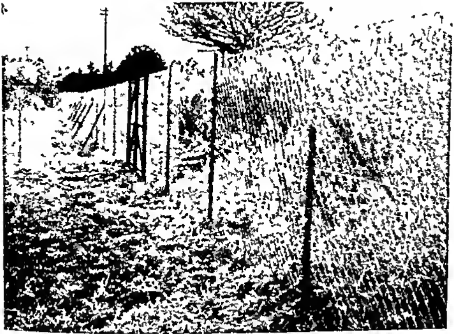


Photo Modern Poultry Keeping

FIG 260.—CHAIN-LINK NETTING AND IRON STAKES MAKE AN IDEAL FENCE, ESPECIALLY SUITABLE WHERE INTENDED TO MOVE THE RUNS PERIODICALLY

gauge is most commonly employed for fencing poultry-runs, the usual height of the fencing being 6 ft. Rather stouter wire (17 or 18 gauge) is more durable.

The life of this material is very short in industrial districts, owing to pollution of the atmosphere with acids It can be prolonged by the application of tar and pitch. If this is done every few years the wire will probably last as long as the house. On some farms it is customary to dip the rolls of wire before erection.

Chain-link fencing is more satisfactory than ordinary wire

up the edge of the netting, they will hold it firmly to the ground.

Fencing Breeding-stock. The lower part of the fencing between adjoining breeding-pens must be boarded up or otherwise covered to prevent male birds fighting through the wire—a common cause of low fertility.

The fencing should be boarded up to a height of 2 ft. from the ground. Feather-edge weather-boarding (unlapped) is commonly used for the purpose. Galvanized-iron sheets are

Photo Modern Poultry Keeping

FIG. 261.—A GENERAL VIEW OF THE BREEDING-PENS ON A PEDIGREE FARM

The solid-floor houses have "outside" nest-boxes with two rows of hopper lights above them Note the cowl extractors The birds in the foreground are Light Sussex flock mated with Rhode Island Red cockerels

also suitable. The boarding or sheets should be supported between the main posts. Sacks attached to the wire will serve the purpose.

Covering the lower part of the runs gives the birds protection from the wind, and is therefore of considerable assistance in maintaining production and fertility at an even level during the winter months, when hatching-eggs are most valuable.

Where extensive rearing is practised boarded hurdles are strongly recommended. They give the chicks the necessary protection and, being readily portable, the runs are easily removed to fresh ground.

The Care of Poultry-plant. Although for the purpose

netting, particularly where it is desired to move the fence at comparatively short intervals, as on farms where large flocks are taken over the fields by a system of folding similar to that employed for sheep. It is, however, expensive, and its use is therefore limited. Plastic netting 6 ft. × 2½ in. sq. mesh is a recent innovation in poultry fencing that has been used with success.

Fencing should be 5 ft. high for the heavy breeds, 6 ft. for the light breeds. On most farms 6-ft. fencing is used throughout.

Fencing posts are usually 2 × 2 in. driven into the ground to a depth of about 18 in. Corner and gate posts should be 3 × 3 in., although 2 × 2 in. is satisfactory if well supported by struts.

Posts should be soaked in creosote preferably by the hot dip method or pressure creosoted. Unless protected in this way they quickly rot just below ground level.

The durability of posts creosoted in the ordinary way will be enhanced very appreciably if a small hole is drilled sloping downwards towards the centre close to the ground level. Filled every year with creosote, the preservative will seep down and protect the wood at the most vulnerable point. The hole should be closed with a plug to keep out rain.

Steel netting stakes are used on some farms. They are particularly suitable for temporary fencing where adult birds are "folded" and for chicken-runs used for short periods only. These stakes, if made of steel of suitable thickness, will give many years' service.

Fencing-posts should be set 10 ft. apart, and the wire should be hung on them, the selvedge being looped over 1½-in. wire nails. One or two nails between the top and bottom of the wire will be sufficient.

Fixed in this way, the wire is readily taken down without damage, whereas if heavily stapled, the staples being driven home, it is practically impossible to remove the wire undamaged.

In order to have the wire flush with the ground, the bottom nail should be driven in before the post is erected, or at least before it is driven home.

Two or three short pegs should be used between the posts. Driven in with a nail at the top turned downward and catching

up the edge of the netting, they will hold it firmly to the ground.

Fencing Breeding-stock. The lower part of the fencing between adjoining breeding-pens must be boarded up or otherwise covered to prevent male birds fighting through the wire—a common cause of low fertility.

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The Care of Poultry-plant. Although for the purpose

of account it is usual to write down the value of houses and other equipment by 10 per cent. per annum, well-built plant will last for twenty years or more if given reasonable care and attention. Indeed, many houses erected in the early twenties are still in service and will last for many more years.

With the exception only of those built with cedar-wood or pressure-creosoted timber, all houses should be treated every year with a wood preservative. Creosote is most commonly used, but it must be of good quality.

Coal tar, especially if a little pitch is added and the mixture applied hot is an excellent preservative and has the advantage of making the timber waterproof. If tar is used, it will be sufficient to dress the houses every two or three years.

This work should be done in a fine spell of weather during the summer months, when the timber is dry and absorbent. Care should be exercised when using creosote, for if it comes in contact with the face or arms it will cause painful inflammation especially in hot weather.

Slatted-floor houses, night arks and other houses used for birds on range should be creosoted or tarred outside and creosoted inside, but those used for intensive or semi-intensive work should, after thorough cleaning and disinfection, be given a coat of limewash or one of the proprietary washes, as this makes the house lighter and brighter.

Proprietary washes are used almost exclusively to-day, both for interior and exterior work. If for any reason limewash is preferred the following recipe is recommended.

Limewash. Slake one bushel of lime in a tub of water, straining through a cloth to remove coarse particles, add 3 lb. size (previously dissolved in warm water) and stir well. Water should be added to the wash until the proper consistency is obtained. Size or starch is necessary to prevent the wash rubbing off.

Chapter Twenty

Poultry Diseases

THE estimated value of the poultry industry in 1960 was £239,500,000 Net loss from mortality was in the region of £12,000,000 To this sum must be added the loss of potential egg production and about £1,000,000 for losses in the broiler industry, which together amounted to about £23,000,000 [1]

Thus it will be seen that the incidence of disease imposes an enormous burden on the industry

Mortality, however, is not evenly spread It varies widely on individual farms Economic surveys show that losses in rearing are as low as 2 per cent and as high as 46 per cent, while losses among laying flocks show wide differences

The incidence of the commoner diseases is shown in Table 46, which presents an analysis of post-mortem reports by Houghton Poultry Research Station for the year ending March 1960

To a very great extent disease is a breeder's problem The fundamental cause of the high rate of mortality is lack of stamina, which means inability to resist disease and to withstand the strain of heavy egg production This, of course, applies only to non-specific diseases, and does not refer to epidemic diseases

That is the opinion of the world's leading experts It is supported by work carried out at a number of experimental centres and by the experience of the leading breeders who have put the health, not only of the individual, but of the family, first in their breeding programme The problem of mortality must be tackled in the breeding-pen

Although selection for stamina is of primary importance, much of the mortality that occurs in all classes of stock could be prevented if the cause were understood and the correct treatment applied at once Unfortunately, on many farms symptoms of the most common diseases are not recognized

[1] Coles Personal communication

TABLE 46

Analysis of Post-mortem Reports (Houghton Poultry Research Station, April 1, 1959–March 31, 1960)

	Chickens			
	0–10 weeks		Adults	
	Birds	Cases	Birds	Cases
I SPECIFIC INFECTIOUS DISEASES				
(a) *Bacterial*				
(i) Pullorum disease	86	19	6	4
(ii) Salmonellosis	351	63	3	1
(iii) Fowl typhoid	1	1	39	24
(iv) Erysipelas	—	—	—	—
(v) Tuberculosis	—	—	19	16
(vi) Infectious coryza	—	—	4	1
(vii) Chronic respiratory disease	67	22	62	25
(viii) Coli septicæmia (air sac infection)	85	21	36	16
(ix) Infectious sinusitis	—	—	—	—
(x) Omphalitis (yolk sac infection)	148	39	—	—
(xi) Unclassified	167	23	3	1
(xii) Fowl cholera	—	—	1	1
(b) *Fungi*				
(i) Aspergillosis	85	26	20	13
(c) *Virus*				
(i) Fowl pest (suspected)	39	10	52	27
(ii) Infectious bronchitis	—	—	4	2
(iii) Fowl pox	—	—	3	3
(iv) Avian encephalomyelitis	447	162	—	—
(v) Infectious synovitis	74	20	69	34
(d) *Avian Leucosis Complex*				
(i) Lymphoid	4	2	261	223
(ii) Myeloid	—	—	1	1
(iii) Erythro	—	—	5	5
(iv) Neurolymphomatosis	93	53	597	430
(v) Ocular	—	—	5	4
(vi) Osteopetrosis	1	1	3	3
(vii) Tumours (unclassified)	2	2	61	61
(viii) Hæmangioma	7	7	39	38
(e) *Parasitic*				
1 *External Parasites*				
(i) Lice	—	—	1	1
(ii) Mites	—	—	2	1
2 *Internal Parasites*				
(i) Coccidiosis—cæcal	380	143	169	103
(ii) Coccidiosis—intestinal	75	36	461	286
(iii) Enterohepatitis	16	11	19	12
(iv) Large round worms	4	2	69	54
(v) Tapeworms	—	—	15	9
(vi) Gapeworms	—	—	—	—
II NON-SPECIFIC DISEASES				
(a) *Nutritional Deficiencies*				
(i) Vitamin A	—	—	15	8
(ii) Vitamin D3 (rickets)	13	5	9	6
(iii) Vitamin E (encephalomalacia)	42	10	—	—
(iv) Perosis	37	18	66	22

TABLE 46 (contd)

	Chickens			
	0–10 weeks		Adults	
	Birds	Cases	Birds	Cases
(b) *Poisoning*				
(i) All types	—	—	3	2
(c) *Vicious Habits*				
(i) All types	7	4	77	66
(d) Egg peritonitis	—	—	145	135
(e) Nephritis (including visc gout, kidney disease)	53	27	177	155
(f) Digestive impactions	54	27	151	120
(g) Diseases of environmental origin	1 351	286	—	—
(h) Chilling and pneumonia	121	41	19	13
(i) Circulatory disorders including pericarditis	22	17	193	172
(j) Liver disorders	7	4	106	94
(k) Reproductive disorders	—	—	44	43
III DISEASES OF INDEFINITE ORIGIN				
(a) Pullet disease	—	—	149	84
(b) Roundheart disease	—	—	14	9
(c) Hæmorrhagic disease	126	36	91	53
(d) Conjunctivitis	22	9	29	19
(e) Ruptured tendon	—	—	27	19
(f) Respiratory disease (unclassified)	10	5	60	49
IV MISCELLANEOUS CONDITIONS				
(i) Sundry conditions including accidents, arthritis abscesses cataract emaciation enteritis and peritonitis	254	97	274	223
(ii) Decomposed	30	15	94	69
(iii) Undiagnosed	902	236	363	225
	5 183	1 500	4 133	2 985

No records were kept of outbreaks of fowl pest which were reported to and dealt with by the Animal Health Division of the Ministry of Agriculture

immediately, nor are experts called in until the trouble, whatever it may be, is firmly established and heavy mortality inevitable

Disease results in great financial loss, in addition to that arising from mortality For instance, millions of eggs are lost annually owing to epidemics of colds, millions of chicks fail to make satisfactory progress for the same reason or because they are infested with worms or coccidia, or are over run with external parasites

These are examples of the sources of serious loss Many

Photo Modern Poultry Keeping

FIG 262 —A POST MORTEM EXAMINATION (1)

First remove all feathers from breast and abdomen Then nail wings and feet to a board and with a sharp knife cut round the breast bone—

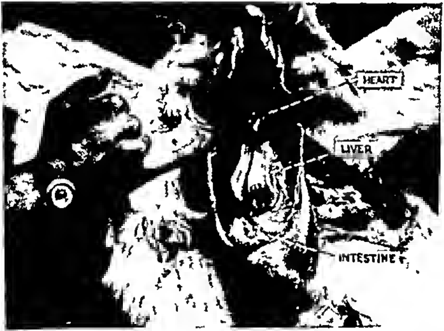

Photo Modern Poultry Keeping

FIG 263 —(2)

This exposes the heart liver and part of the intestines

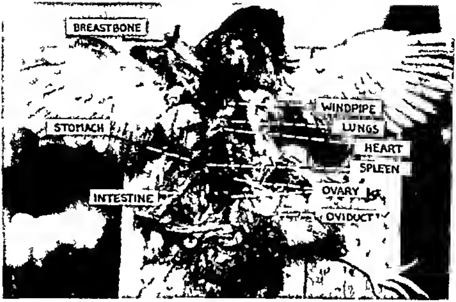

Photo Mod n Pou ry Keep g

FIG 264 —(3)

The ribs should be cut with small shears and the breast bone turned back When the liver is removed the ovary and oviduct can be seen In this b rd the ovary is active

Photo Mod rn Pou ry Ke p ng

FIG 265 —(4)

Removal of the intest nes reveals tl e kidneys tl at l e close to the sp ne Here the o ary is nacti e the mmature yolks l av ng the appearance of yellow sh wh te beads

more could be given, all of them commonly seen on farms that, their owners claim, are well managed.

Prevention of Disease. Many outbreaks of disease arise from failure to apply simple measures of disease control, particularly with regard to the introduction of new stock, the careless handling of food sacks and poultry crates.

So far as possible, new stock should be bought in the form of

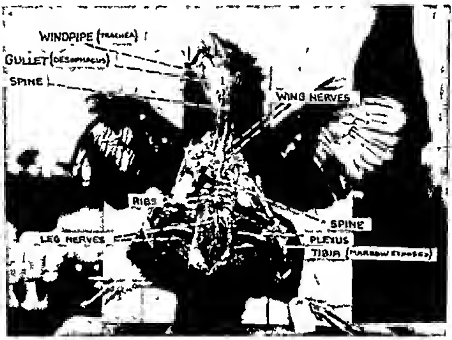

Photo Modern Poultry Keeping

FIG 266.—(5)

With the ovary and other internal organs removed, the spine, ribs, wing and leg nerves are clearly seen

hatching eggs or day-old chicks If growing stock is purchased *it should be reared away from home-bred stock and adult birds.* Growing birds should never be reared on land recently occupied by adults. If adult birds are purchased they should be kept in quarantine for a minimum period of three weeks.

No attempt should be made to treat individual birds other than those affected by simple non-infectious conditions, *e.g.*, prolapsus and bumblefoot, and even in such cases treatment is of doubtful economic value.

An isolation pen for the sick should not be provided. A

hospital can be a menace to the health of the farm's stock. Dead birds should be burnt or buried deeply in lime.

Rats and mice should be eradicated. They spread disease; they are common carriers of organisms of the Salmonella group.

Poultry manure should not become a breeding ground for flies. Manure should not be stored in close proximity to the birds. It should be composted or taken to arable land and ploughed in.

Whenever a flock shows symptoms of ill-health prompt qualified veterinary advice should be sought or carcases sent to a veterinary laboratory. In the case of farms operating under the Poultry Stock Improvement Plan mortality must be reported to the Regional Poultry Advisory Officer or the County Poultry Advisory Officer and specimens sent to the Ministry's Veterinary Laboratories in accordance with the Regulations of the P.S.I.P. Free veterinary advice is given to farms, within the scheme. In the case of suspected fowl pest the owner must notify the police or the Divisional Veterinary Officer.

The purpose of this chapter is to describe in the simplest terms the symptoms and treatment of the commoner diseases of poultry. There is a wealth of literature available to the reader who desires to study the subject more fully, and he is advised to consult the excellent books written by qualified veterinary surgeons who have specialized in this work.

DISEASES MAY BE CLASSIFIED AS FOLLOW:

(A) **Specific.** Infectious or contagious and caused by definite, specific agents—bacteria, viruses, protozoa, fungi or larger parasites (worms and external parasites)

1 *Diseases due to Bacteria*
   1. Bacillary White Diarrhœa (Pullorum Disease)
   2 Salmonellosis
   3 Typhoid
   4 Cholera
   5 Tuberculosis
   6 Contagious Catarrh
   7 Chronic Respiratory Disease
   8 Omphalitis

2 *Virus Diseases*
   1 Fowl Pox
   2 Infectious Laryngo-Tracheitis
   3 Pest (Fowl Plague Newcastle Disease)
   4. Lymphomatosis
   5 Infectious Synovitis
   6 Infectious Bronchitis
   7 Epidemic Tremor

3 *Fungoid Diseases*
   1 Aspergillosis
   2 Favus

4 *Protozoan Diseases*
   1 Coccidiosis
   2 Blackhead

5 *Internal Parasites*
   1 Round-worms $\begin{cases}\text{Cæcal}\\\text{Large.}\\\text{Gape}\end{cases}$
   2 Tapeworms

6 *External Parasites*
   1. Lice
   2 Mites
   3 Fleas

(B) Non specific

1 *Deficiency Diseases*

Vitamin A (Nutritional Roup)
B Riboflavin (Curled Toe Paralysis)
B Pantothenic Acid (Dermatitis in chicks)
D Rickets
E Crazy Chick
Perosis (Slipped Tendon)

2 *Constitutional*

1 Abdominal Dropsy (Ascites)
2 Bronchitis
3 Bleeding Cysts
4 Bumblefoot
5 Canker
6 Clogging of Beak
7 Congestion of Lungs
8 Convulsions
9 Crop Binding and Sour Crop
10 Diarrhœa
11 Diseases of the Liver
12 Dropped Abdomen
13 Layer s Cramp
14 Limberneck Wryneck
15 Obstruction of the Oviduct (Egg Bound)
16 Œdema of the Wattles
17 Peritonitis
18 Prolapsus
19 Vent Gleet

3 *Poisoning*

1 Arsenic
2 Phosphorus
3 Zinc Phosphide
4 Salt

(C) Unclassified

1 Pullet Disease
2 Six-day Chick Disease.
3 Hæmorrhagic Disease

(D) Vices

1 Toe Pecking
2 Feather Plucking and Cannibalism
3 Egg-eating

Diseases Due to Bacteria *Bacillary White Diarrhœa (B W D or Pullorum Disease)* Prior to the general application of the blood test and other measures of control this disease was responsible for enormous losses among young chicks In virulent outbreaks the death rate may reach 80 or 90 per cent Outbreaks continue to occur, but they are far less numerous than formerly Control has been so effective that the disease is no longer as important as it was years ago

The causal organism was isolated by Rettger in 1900 It is known as *Salmonella pullorum* His discovery was followed by investigations by many scientists, and these have resulted in extensive knowledge of the disease, especially with regard to control measures

In 1910 Rettger and his associates showed that infection

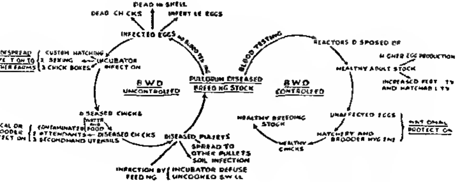

FIG. 267.—DIAGRAM OF BACILLARY WHITE DIARRHŒA INFECTION

occurs by way of the egg, and that a proportion of the survivors of an outbreak continue to carry the organism in their bodies, especially in the ovary, and that a variable percentage of the eggs laid by carrier hens are infected.

In view of this it was obvious that if infected birds could be

FIG. 268.—OVARY FROM BACILLARY WHITE DIARRHŒA CARRIER

Note distorted shape of ovules and long stalks. This bird was also affected with tuberculosis. The small raised nodules on the surface of the ovary are due to the latter disease

Photo J. F. Wilson

FIG. 269.—BACILLARY WHITE DIARRHŒA

Heart of adult carrier showing nodules

identified and removed from the flock, a prevalent, but not the only, source of infection could be eliminated

In 1913 the agglutination test was adopted for this purpose This test is based on the fact that when certain diseases establish themselves in the body, protective substances are produced with which the body defends itself These substances are called "antibodies" Their presence in the tissues results in the clumping together or agglutination of the invading bacteria, which are then more readily destroyed

Photo J E Wilson

FIG 270—RAPID WHOLE BLOOD TEST FOR BACILLARY WHITE DIARRHŒA

A Negative result The fluid remains cloudy

B Positive result Clumping occurs which gives the fluid a granular appearance

When a small sample of blood is taken from the birds that are or have been infected with B W D and is mixed with a solution of dead B W D germs—this solution is called "antigen"—the agglutinins in the blood will cause the bacteria to clump together or agglutinate No such clumping occurs if the birds are not or have not been affected

There are two methods of blood testing the tube method used only in the laboratory, and the rapid or "spot" method carried out in the field In the former test the blood serum is tested, in the latter, whole blood

When the tube test is applied blood is drawn from the large vein which passes over the "elbow" on the lower surface of the wing The blood is collected in small glass tubes, and the number of the bird is written on the tube and on a record card The tube is then sent to a laboratory, where the blood is tested

In recent years the rapid test has largely superseded the tube test When carried out in the field, the rapid test identifies reactors at once, thus saving much time and labour

A spot of blood is taken from the comb or wing-vein and mixed with antigen on a glass or glazed plate If the blood is from a carrier bird, clumping occurs, but if the bird is not a carrier, the blood and antigen mixture remains turbid

At one time considerable doubt was expressed with regard to the accuracy of the rapid test, but improved technique is now adopted The rapid method is employed by the Ministry of Agriculture for the testing of flocks under the Accredited Breeders' Scheme

During 1942–43 the Ministry carried out large scale experiments to test the accuracy of the two methods Over 15,000 birds were tested by both methods There was complete agreement between the whole blood and rapid tests in 98 76 per cent of the birds (Gordon, 1946)

Although the test is reliable, it is not infallible Nevertheless, if reliable antigen is employed and the work is carried out by competent testers, experience has shown that it is possible to eradicate the disease and to keep flocks free from infection by testing every season

It should be pointed out that when a bird becomes infected it does not at once react to the test Time is required for the production of agglutinins in the blood Experiments indicate that the interval between infection and reaction is from twenty-one to thirty days For this reason, when reactors are found in the flock, subsequent tests should be made at three-to-four week intervals until no reactors are found Alternatively, the flock, after removal of reactors, may be treated with furazolidone, to which reference is made on p 679

Further, the degree of reaction depends to some extent on the activity of the ovary If possible, birds should be tested when in lay

Some individuals fail to give a clear reaction They should be discarded or, if considered sufficiently valuable, they should be isolated and re-tested three or four weeks later

The greatest infection occurs in the incubator and during the first few days after hatching Growers and adults can also become infected from infected excreta, contaminated food and water Therefore close attention should be paid to sanitary conditions If a flock is infected, non-reacting birds should be removed to fresh ground

As a precautionary measure, incubators should be thoroughly disinfected after each hatch (preferably by formaldehyde fumigation), while brooders and all rearing equipment should be washed and disinfected A 4-per cent solution of washing soda in hot water is effective This is approximately equivalent to a heaped handful in 1 gal of water (See " Fumigation ", pp 231, 240)

In order to destroy organisms that may be present on the shell of the egg, some hatcheries fumigate the eggs prior to incubation with formaldehyde gas at strengths recommended on p 241 The process involves the use of air-tight fumigation chambers

Lancaster, Gordon and Tucker (1952) in a series of experiments at the Houghton Poultry Research Station found that —

(1) [1] The following disinfectant solutions when used at 25° C were efficient in the removal of *S pullorum* from artificially infected clean and dirty eggs, 0 2 per cent Sod salt of para-toluesulphonochloramide (Chloramine T), 1 8 per cent of 10 per cent sodium hypochlorite (" Deosan "), the addition of detergent (" Teepol XL ") to the preceding increased their effectiveness 0 5 per cent cetylthrimethyl ammonium bromide (" Cetavlon "), 1 5 per cent chlorometa xylenol (" Dettol ")

The immersion time was maintained at 15 minutes for all the disinfectants tested

(2) The hatchability of eggs immersed in at least double the effective strength of the various disinfectants was tested Results indicated that the solutions had no determined effect on the hatchability

(3) The stability of the solutions following the immersion of successive groups of eggs was examined A 0 4 per cent solution of para-toluesulphonochloramide plus detergent retained its ability to kill *S pullorum* to a maximum of forty-six successive immersions

(4) *Salm thompson* and *Salm typhimurium* were more resistant to the action of the disinfectants tested.

(5) The present series of disinfectants were found to be of no value in the control of egg rots during the storage of consuming eggs

[1] *The British Veterinary Journal* Vol 108 page 418

The symptoms of B.W.D. are not diagnostic. Some chicks may die without showing symptoms of ill-health. Usually, however, symptoms begin to appear when the chicks are three or four days old, and losses are usually heavy from this stage up to about ten to fourteen days.

Affected chicks appear sleepy, the down is staring, the wings droop. The chicks huddle in the brooder, bleat when disturbed and frequently make a peculiar chirping sound due to pain when passing their droppings. A whitish diarrhœa is a common symptom, the excreta adhering to the fluff around the vent, which is often completely blocked. The abdomen is frequently enlarged.

In adults symptoms are rarely seen. Occasionally, affected birds may have diarrhœa, but as a rule they have every appearance of being healthy.

Whenever abnormal mortality occurs among a batch of baby chicks a number of bodies should be sent to a laboratory for post-mortem examination. This holds good for all chick diseases.

In the event of an outbreak of this disease, the breeding-stock, including of course the males, should be re-tested, or if the chicks are not home-bred, the supplier should be notified.

It has been known for some years that various "sulpha" drugs are effective in the treatment of this disease in chicks. Losses can be reduced by the administration of these drugs, but the survivors may remain carriers and react to the blood test.

More recently, however, furazolidone has been used successfully by workers both in this country and overseas.

In 1954 Williams-Smith reported that when the drug, which belongs to the same group as nitrofurazone (now widely used for the prevention and treatment of coccidiosis), was added to the mash at a level of 0·04 per cent for ten days a high proportion of the chicks recovered and few became carriers.

Later it was shown (Gordon and Tucker, 1955) that when adult carriers are treated with the drug at the same level and for the same time, in the majority of cases the birds are sterilized, *i.e.*, they are no longer capable of transmitting infection, although they may continue to react to the blood test for a lengthy period.

It is, of course, possible that in heavily infected flocks non-reactors may pick up infection from contaminated ground. As a precautionary measure against this contingency Gordon suggests using the drug at the prophylactic level of 0·01 per cent for a short period following treatment for ten days at the therapeutic level of 0·04 per cent.

Gordon (1955) reported the result of a large-scale field trial involving 81,000 birds in thirty-one flocks containing 200 reactors. All flocks were treated with furazolidone, and on retest thirty of the flocks showed no reactors, and there was only one in the flock that did not give a completely clear test.

Thus it will be seen that the drug is of great value in the prevention and treatment of the disease, but it should not be regarded as an alternative to blood testing. It is an additional insurance against the disease. It is especially valuable when reactors are found in the flock, since the birds can be treated and the eggs used for hatching without repeated retesting of the flock.

In the treatment of chicks the drug should be used as soon as the presence of the disease is suspected. Given as advised, furazolidone has no harmful side effects. Prolonged use, however, has been shown by Cooper and Skulski (1956) to produce changes in the gonads of the male. Whether this affects fertility has not yet been ascertained. No detrimental effect was found in the case of treated females.

Variant strains of *S. pullorum* have occurred in this country, but they do not appear to diminish the value of routine blood testing.

Carnaghan and Sojka (1958) reported outbreaks of arthritis in broiler chicks in which a variant strain was incriminated. Usually mortality is about 5 per cent, but may be as high as 20 per cent.

Symptoms are lameness, swelling of the hock and foot joints, poor feathering and slow growth. Losses usually occur between ten days and five weeks of age.

Survivors of experimentally produced infection did not react to blood testing with a standard pullorum antigen, but reacted to one prepared from the variant strain.

Salmonellosis. For many years occasional outbreaks of mortality in chicks caused by organisms of the *Salmonella*

group other than *S pullorum* have been reported In recent times these infections have become more prevalent They are an important cause of loss in broiler chicks

Many organisms of this group are known to cause disease in poultry In this country more than fifty species have been isolated, but many are of rare occurrence, and outbreaks due to exotic species tend to be restricted to the group of birds concerned, they do not tend to become established in our poultry flock (Gordon, 1959)

The majority of outbreaks in this country are still caused by *S thompson* and *S typhimurium*

The great variety of types has led to the use of the term "Salmonellosis" or "Salmonella infection' being applied to the disease caused by these organisms

Infection is not confined to one species of fowl In addition to chicks, it has been reported in ducklings, goslings, turkey poults, pheasant chicks, pigeons and canaries In Great Britain outbreaks most commonly occur among chicks and ducklings

Mortality is very variable In some outbreaks only a few chicks may die, in others losses may be as high as 80 or even 100 per cent

Chicks dying within a week of hatching usually show no definite symptoms Older chicks may stagger, fall over and twist the head—this has given rise to the term "Keel disease" These symptoms are not, however, characteristic, and in all cases where mortality is greater than usual bodies should be sent to a laboratory for examination

Although Salmonellosis closely resembles B W D, research has shown that, in many respects, it is not precisely similar, for direct infection from the ovary to the yolk does not appear to be so common as in B W D

Infection occurs through the organisms penetrating the shell, especially under the humid conditions in the incubator

The disease is very infectious among young chicks It may be spread by food and water contaminated with the droppings of infected birds It should be pointed out that rats and mice are frequently infected with certain of these organisms and spread infection by contaminating food and water

Chicks that survive an outbreak may become carriers and spread infection in the droppings.

Work by Gordon and Buxton and by Wilson has shown that improvements in clean egg production result in an immediate drop in the infectivity rate on the outside of the shell, and that this is one of the most satisfactory methods of controlling the disease.

Dirty eggs should never be cleaned by wiping with a wet cloth, which only serves to spread the area of the infection and hasten penetration. They should be cleaned by dipping in a germicidal solution such as quaternary ammonium chloride. Many dip all hatching eggs as a precautionary measure.

Blood-testing for the purpose of identifying carriers is of doubtful value. Gordon (1947) made the following observations:—

"In many of the outbreaks investigated, blood-testing, and the elimination of Salmonella reactors has not influenced the mortality in the chicks or ducklings, since in many cases the infection has arisen from some extraneous source. Furthermore, carriers vary enormously from time to time in their response to tests carried out with Salmonella antigens, and reactions may persist for some time after birds have ceased to be infected.

"In certain selected outbreaks blood-testing may be of some value provided the exact type of organism involved has been identified and a special antigen made from it."

Gordon emphasized, however, that this does not affect the efficiency of blood-testing for B.W.D. and fowl typhoid.

It has been shown by Smith, Wilson *et. al.* that furazolidone (0·04 per cent) in the diet effectively controls mortality resulting from *S. typhimurium* infection.

Unfortunately a high proportion of the survivors become carriers and should not be used for breeding stock.

Fowl Typhoid. Fowl typhoid is an infectious disease caused by an organism belonging to the same large group (*Salmonella*) that includes the organisms responsible for B.W.D. It is, however, a specific disease arising from *S. gallinarium.*

At one time this disease was largely restricted to certain areas of Wales and the West Midlands, where outbreaks were most commonly reported, but more recently it has spread to many other parts of the country, particularly the East and

North Ridings, North-West Midlands and elsewhere. The disease is mainly one of adult birds—extensive outbreaks among chicks are rare.

Fowl typhoid is more prevalent among flocks on range than among those kept under intensive conditions.

In common with other diseases, outbreaks vary in their virulence. Occasional cases occur on some farms without infection becoming general. Odd birds may die from the disease from time to time.

In the event of an epidemic mortality may be very heavy. Symptoms are not diagnostic. Affected birds are sleepy and stand in dark corners, the head being drawn into the shoulders. The feathers are dull and loose, the wings droop. The comb, face and wattles are usually pale, but may be very dark. The most characteristic symptom is greenish-yellow diarrhœa, the droppings being liquid and having an offensive odour.

Some birds may recover and become " carriers ", thus acting as a potential source of infection for subsequent outbreaks.

Blood testing for the identification of carriers may be undertaken. The test is as reliable as that for B.W.D., but in field practice results may be disappointing owing to reinfection.

Dead vaccines have been produced, but they have not proved of great value. Williams Smith (1956), however, reported on two highly efficient live vaccines developed at the Houghton Poultry Research Station.

Extensive field trials carried out by the Ministry of Agriculture confirmed the value of these vaccines, one of which, known as " 9R ", is now available commercially.

The vaccine although of the live type is of low virulence and can be used without risk of causing infection. Moreover, injection of the vaccine will not interfere to any great extent with normal reaction to the blood test for B.W.D. as was the case with other fowl typhoid vaccines.

Vaccination is carried out with hypodermic syringe. The best time for vaccination is between eight and sixteen weeks of age, which will confer a high degree of immunity on the birds when they are normally most susceptible to infection, *i.e.*, at point of lay and during the early laying season.

As with other vaccines, this should not be regarded as a cure for the disease, but as a means of prevention.

Williams-Smith (1954) showed that when artificially infected chicks were treated with furazolidone in the mash at the rate of 0 04 per cent for six to twelve days 98 per cent survived, whereas mortality among the untreated chicks was 77 per cent Furthermore, only one of the eighty-eight treated chicks which survived became a "carrier"

Field trials have confirmed this result The drug is now widely used at the rate of 0 04 per cent in the mash Furazolidone is not equally effective in the eradication of certain other salmonella infections, *e g*, *S typhimurium*, a common cause of paratyphoid poisoning in man

While the drug used at the 0 04 per cent level for *ten* days controls losses among infected flocks, some of the birds that recover are carriers and spread infection in the droppings

In the event of an outbreak both drug treatment and vaccination are now advised The affected flock should be given furazolidone at 0 4 per cent level in the *mash for* ten days The birds should then be moved to clean premises and the treatment repeated for a further ten days

If the birds are vaccinated with "9R" a week after the first or second treatment with furazolidone almost complete protection is assured

Treatment must be supported by the application of sound principles of hygiene

Diet and Infection Williams-Smith (1954) studied the effect of variations in the diet on the induction of fowl typhoid infection He found that the addition of fish meal to a cereal diet lowered the acidity of the gizzard contents, and as a result there was a lesser degree of destruction of the organisms and higher infection

Further research showed that the influence of fish meal on the acidity of the gizzard contents was likely to be due to the ash rather than the protein of the meal

The effect of the consistency of the food was shown by comparing diets containing whole wheat and wheat meals It was found that there was a much lower infection rate when whole wheat was fed compared with wheat meals, the difference being due to the fact that bacteria are exposed to the action of the gastric juice for a longer time when whole wheat is fed, since the food is retained in the gizzard until it is ground

Fowl Cholera Fowl cholera is a highly infectious disease

affecting fowls, ducks, geese, turkeys, etc It s caused by a bacillus present in the blood and droppings of affected birds There are two distinct types of this disease acute and chronic

The acute type occurs from time to time in this country, although no extensive outbreaks have been reported in recent years, probably on account of the restrictions on imported poultry to which some past outbreaks could be traced

With the acute type losses are usually severe The disease takes a rapid course, some birds may die within eight hours of showing symptoms, although usually they linger for a few days Mortality may be as high as 80 or 90 per cent

The symptoms are moping, rapid breathing and greenish diarrhœa Later the droppings become very watery and greenish red The birds have great thirst Respiration becomes increasingly rapid and laboured, the comb and wattles, at first pale, later become a dark bluish red

Some individuals will recover, but they may become "carriers," and, while showing no symptoms themselves, spread infection to others This is most likely to occur when "carriers" are moved to other flocks not previously exposed to infection, and which are therefore susceptible

Evidence that the disease is transmitted through the egg is lacking

The organisms are passed in great numbers in the droppings of affected birds, and thus contaminate the ground, litter, drinking water and food

When an outbreak occurs all affected birds should be killed and their bodies burned The houses and equipment should be cleaned and disinfected, and the runs should not be occupied by any species of poultry for at least two months

Care must be taken to avoid carrying infection on the boots, hands and clothes of the attendants

The chronic type of this disease usually results in occasional losses, odd birds dying from time to time Then the trouble may clear up Sometimes it is confined to a section of the farm

In some outbreaks the birds have running nostrils, swollen faces, eyes and wattles Swollen wattles are quite a common symptom of a localized form, especially in male birds, but it must not be assumed that every bird having swollen wattles is necessarily suffering from this disease

The usual sanitary measures should be carried out as a precaution against a more virulent attack. The mild type of the disease may persist for some time.

Tuberculosis. Tuberculosis is a common disease of poultry. It is frequently termed "going light," but this is misleading because it merely describes a symptom that occurs with many other diseases.

In poultry, tuberculosis is of the avian type, which is quite distinct from the human and bovine types.

In 1946 the Ministry of Agriculture announced that there is no prohibition on keeping poultry with attested or licensed tuberculin-tested cattle, but before the introduction of the comparative tuberculin test owners were advised to segregate poultry from cattle.

This precaution was advocated because avian tuberculosis, the only type found in poultry, is communicable to cattle. So far as is known, however, it does not cause progressive disease in cattle, nor is it communicable to the milk supply, but animals that pick up the avian type of tuberculosis with grass or fodder may react to mammalian tuberculin.

The employment for official purposes of the comparative tuberculin test, in which both avian and mammalian tuberculins are used, has, however, made it possible to determine whether a reaction is due to infection with bovine tuberculosis or avian or other non-bovine infection. This development has enabled owners of attested and licensed tuberculin-tested herds to undertake poultry-keeping on an unrestricted scale.

In certain circumstances, however, there are disadvantages in allowing poultry free range. Many importing countries will not accept animals unless they have passed a tuberculin test with mammalian tuberculin. As there is a risk that an animal infected with the avian type of tuberculosis may react to the test and be rejected, owners of cattle that may have to pass a test in which mammalian tuberculin only is used would be well advised to segregate their poultry from their cattle.

Pigs are very susceptible to avian tuberculosis, and should not be run in contact with poultry. The avian type is also found in ducks, geese, turkeys, pheasants, etc.

There is a common belief among poultry-men that tuberculosis is a disease of older birds only. This is not so. Young

birds frequently become infected, but since the disease usually takes a slowly progressive course, symptoms may not appear until the second year. As a rule, the mortality is low and is spread over a considerable period.

Affected birds usually lose weight, in the later stages becoming extremely emaciated. The comb and wattles, become pale, but the eyes are usually bright. Diarrhœa is a common symptom. Lameness and enlargement of the joints may also occur.

Sometimes a bird in good bodily condition may die suddenly. In such instances death is usually caused by internal hæmor-

Photo J. E. Wilson

FIG. 271.—TUBERCULOSIS OF THE LIVER AND SPLEEN

These organs are studded with yellowish white nodules

rhage due to the rupture of liver or spleen. This may follow jumping from the perch, or even careless handling by the attendant.

Post-mortem examination usually reveals enlargement of liver and spleen. These organs, together with the intestines, usually contain cheesy nodules or tubercules varying in size from that of a pin's head to a pea. They are a yellowish colour. The whole intestinal tract may contain large numbers of these nodules. In poultry the lungs are rarely affected.

Treatment should not be considered for one moment. When tuberculosis is present in a flock and there is reason to believe that infection is widespread, all the birds should be

are terms commonly used by the poultryman to describe a catarrhal condition characterized by watery discharge from the nostrils and eyes, the discharge subsequently becoming thicker The birds sneeze and shake their heads in an endeavour to get rid of mucus in the nostrils

Unfortunately these symptoms are similar to those of other respiratory diseases, and it would be dangerous for the poultryman to assume that they are diagnostic of "colds". He should seek veterinary advice immediately his birds show the above symptoms

In view of complexity of respiratory diseases of poultry, Gordon[1] suggests that the use of the term "coryza" should be restricted to the mild form of colds—frequently called "summer colds"—caused by the organism *Hæmophilus gallinarum*

Swelling of the face and eyes and the accumulation of cheesy material which frequently follow early symptoms of colds usually occur in chronic respiratory disease and are the result of secondary infection

Hæmophilus coryza is relatively unimportant, some authorities regard it as a comparatively rare condition to-day, but this, of course, does not imply that it may be the fore-runner of more serious diseases or that it is not responsible for impaired growth and a fall in egg production

The condition responds to treatment with sulphonamides Sulphathiazole fed in the mash at the level of 0 5 per cent or as a sodium salt in the drinking-water at the 0 1 per cent level is perhaps most commonly used

Sulphamezathine at the same dosage as recommended for coccidiosis is also effective

If there is no response to treatment within about a week it is probably that a different type of infection is implicated

The birds should be liberally fed on nourishing wet mashes containing cod-liver oil It is advisable to discontinue dry-mash feeding during an epidemic High-level feeding of antibiotics is of value in the event of an outbreak of this and many other diseases

Attention should be paid to the ventilation of the houses and sanitary conditions generally Water- and food-troughs should be disinfected daily

[1] Personal communication

Chronic Respiratory Disease. Chronic respiratory disease, usually referred to as C R D (also air-sac infection), is a major cause of mortality in American broiler plants Numerous outbreaks have been reported in this country, and in view of the growth of the broiler industry they may become more widespread

Most workers believe that the causal agent is a pleuro-pneumonia-like organism similar to or identical with that causing sinusitis ("swollen head") in turkeys

It should be pointed out, however, that it is not unusual for the P P L O to be associated with a primary virus disease such as infectious bronchitis, fowl pest or infectious laryngo-tracheitis and that secondary infections with coliform organisms causing swollen face, infected air sacs and associated conditions is the rule rather than the exception

In view of this interaction between a number of conditions, some workers now feel that the title Chronic Respiratory Disease should be replaced by "Respiratory Disease Complex"

Mortality among chickens is not usually high, although in some outbreaks heavy losses have occurred Economic loss arises mainly from slower growth, poor carcase quality of table chickens and lower egg production

The disease spreads rapidly by contact with infected stock or infective materials The danger of infection in large groups of birds in broiler-houses will be recognized

C R D is also spread through the hatching egg, indeed, it has been stated that some 40 per cent of eggs may be infected

Birds that have recovered from the disease may become "carriers"

Symptoms resemble those of colds and coryza and many other respiratory diseases, namely running nostrils, sneezing and laboured breathing accompanied by rattling sounds Nasal discharges soon become thick Tear ducts and sinuses become blocked, causing swelling

Diagnosis of C R D is complicated It calls for investigation by laboratory workers specializing in respiratory diseases in order to isolate the causal organisms responsible for specific outbreaks

C R D responds to intramuscular injection of antibiotics such as streptomycin, while high-level feeding of antibiotics such as aureomycin and terramycin for ten to fourteen days may

be beneficial, probably on account of their effects on secondary organisms

Furazolidone is also of value in the treatment of this disease

Following an outbreak, the usual sanitary measures should be applied to get rid of infection in premises and equipment Houses should be de populated, litter removed and burnt and the interior of the houses thoroughly washed and disinfected

Omphalitis This disease, also known as navel ill, yolk infection and mushy chick disease, is caused by bacteria invad ing either the yolk, resulting in greater or lesser breakdown of the yolk contents and inflammation of the yolk sac, or the navel, which becomes much enlarged, the tissues about the navel being swollen and necrotic

The former condition is true mushy chick disease, whereas the latter is true omphalitis or navel ill

Outbreaks of both forms of the disease can cause serious losses among chicks

A variety of different bacteria, many normal inhabitants of the adult hen's intestines, have been identified in outbreaks Gordon (1959) reported two outbreaks of yolk sac infection with staphylococci which involved both embryonic and chick mortality traced to people who were nasal or skin carriers of the organisms handling hatching eggs on the eighteenth day of incubation

Control measures must be directed towards improved hygiene on breeders farms and in hatcheries, suitable storage conditions for eggs, dipping or fumigation of eggs prior to incubation, routine fumigation during incubation and a high standard of hygiene in chick sexing and packing rooms

Escherichia coli Infections Recently *E coli* infections have been responsible for mortality and poor growth among broiler chicks Outbreaks have occurred in chicks of six to ten weeks of age resulting in losses of 7 10 per cent, with considerable consequen tial loss due to downgrading of survivors

Organisms of this group are present in large numbers in the gut of chicks a day or so old, and are normally harmless Certain strains, however if they invade the blood stream either through the gut or by other routes can cause infection in other organs and tissues

Symptoms of the disease are similar in many respects to those

of C R D, with which it may be associated, but there is no nasal discharge or swelling of the face

It has been noted that the disease is more prevalent in winter. This suggests that it may be associated with faulty ventilation and spread by the breath

Affected chicks show the usual symptoms of ill-health, they stand about with head drawn close to the body, the feathers are ruffled and the eyes may be closed The appetite is poor Some chicks may have yellowish diarrhœa

Post-mortem examination reveals enlargement of liver, heart and kidney, with yellowish gelatinous material covering them The material may be found also in the air sacs and under the skin, which may be dry.

C R D when associated with *E coli* infections may result in high mortality because the latter impair resistance to the former Thus C R D, usually a comparatively mild type of disease, may assume epidemic proportions if the birds are debilitated in some degree by *coli* infections

Should an outbreak be suspected, carcases should be submitted without delay to a laboratory for examination

This is a new disease of chicks In the light of present knowledge it may be said to be a disease of large intensive-rearing units

Many strains of the *E coli* isolated have been found to be resistant to tetracyclines, probably as a result of their continuous use in broiler diets

High-level feeding of antibiotics gives inconsistent results for this reason

Furazolidone at 0 04 per cent of food for seven to ten days is also recommended

Virus Diseases. *Fowl Pox.* Symptoms of fowl pox are similar to those described for catarrh and " roup ", with the exception that wart-like lesions appear on the comb and wattles, in the head type of this disease, and these lesions are usually present in at least some of the birds If fowl pox is suspected and lesions do not appear in any of the birds, a few specimens should be sent to a laboratory for examination

Fowl pox is extremely contagious, rather than infectious, that is to say the disease is spread by direct contact between birds or contact with infective material

Outbreaks often follow wounds caused by fighting. It is known that infection can be spread by blood-sucking parasites.

The disease may cause high mortality. It usually spreads slowly at the outset, so that if early cases are destroyed and general disinfection is carried out the outbreak may be controlled. Flock treatment is similar to that recommended for contagious catarrh.

Photos J E Wilson

FIG. 273.—COMB AND MOUTH TYPES OF FOWL POX

The spots or warts on the comb, etc., should be painted with tincture of iodine. The false membranes in the mouth should be carefully removed and the raw surface treated similarly.

Fowl pox may be prevented by vaccination. The vaccine used in this country is prepared from pigeon-pox virus, and was first perfected by Doyle at the Ministry of Agriculture's Veterinary Laboratory.

Vaccination is a simple process. A few feathers should be plucked from the thigh and the exposed skin scratched with a scarifier supplied with the vaccine. Scratching should not cause bleeding, but it should be sufficiently deep to allow the vaccine to enter.

If reliable vaccine is employed and the operation is properly carried out, reaction will be seen five to seven days later, when feather follicles of the vaccinated area will be swollen. If reaction does not occur, the bird may be naturally immune, or the vaccine ineffective or the work not properly carried out.

Vaccination does not give immediate protection It requires up to about twelve to fourteen days to become effective This treatment will give immunity for about six months After this period the effect gradually wears off

Should there be any reason to fear an outbreak of fowl pox, vaccination should be done in the late summer—early in September. This will give protection during the winter months, when an epidemic is most likely to occur

Vaccination should be regarded as a preventive of fowl pox, not as a cure for the disease Nevertheless, it is possible to vaccinate early cases with success, provided they are strictly isolated from healthy stock This vaccination causes a temporary increase in the severity of the disease, but treated birds usually recover Birds may be vaccinated at any age (even at a day old).

The importance of isolating newly purchased stock and stock returned from shows and laying-tests cannot be overemphasized Many epidemics have been caused by placing apparently healthy birds in the flock immediately on their arrival at the farm

Vaccination will give protection only against true fowl pox It will not protect the birds against the common cold and other catarrhal conditions

Infectious Laryngo-tracheitis This is one of the most serious poultry diseases in this country where the first outbreak was reported in the mid-thirties Sporadic outbreaks occurred subsequently, they were largely confined to table-poultry plants

During the war and early post-war years the disease almost disappeared In recent times, however, numerous outbreaks have been reported, mainly in areas of high poultry population in the north-west of England

In some districts losses arising from this disease are so serious that some poultrymen consider that it ranks equally with fowl pest in economic importance

As with other diseases I L T (also known as contagious bronchitis and Canadian 'flu) occurs in different degrees of virulence

In the acute form mortality is very high, commonly exceeding 70 per cent It is this form which shows the most clear-cut symptoms

The affected bird has great difficulty in breathing it extends its neck, closes or partially closes its eyes opens its beak and breathes slowly, making a gurgling or rattling sound It shakes its head in an effort to expel the mucus in the trachea, and may cough up blood or blood stained mucus, which may be found about the houses and runs The comb face etc are usually dark in colour The bird becomes progressively weaker, and finally dies from exhaustion Death usually occurs within about a week of the onset of symptoms, and birds which survive remain carriers for at least a year

In the chronic form of the disease mortality is low, possibly less than 5 per cent In some outbreaks only the odd bird may be lost

Birds affected with this form do not show the marked symptoms associated with the acute form, they do not become distressed Symptoms resemble those of mild colds—nasal discharge, loss of condition and in the case of laying flocks a decline in egg production, although the latter does not usually occur so suddenly as in fowl pest

I L T is not so highly infectious as many other respiratory diseases, and if a high standard of hygiene is maintained it may be possible to contain an outbreak to a section of the farm

Greatest risk of the spread of infection arises from carrier birds Birds that have recovered from an outbreak may not only cause infection among other flocks if sold off the farm but may provide the media for perpetuating infection from season to season if retained on their native farm

In no circumstances should live birds be sold off the farm while the disease is active Recovered birds should be marketed for table

An outbreak or suspected outbreak should be reported immediately to a veterinary officer of the Animal Health Division of the Ministry of Agriculture

An entirely reliable vaccine has been prepared and is in common use in America It gives lasting protection against infection and has no adverse effects on the stock Vaccination of laying flocks does not lower egg production

Since a live vaccine is employed it may in certain circumstances cause a spread of infection Vaccines are not at present available in this country

If an outbreak is confirmed veterinary advice should be followed.

Fowl Pest. *Newcastle Disease: Fowl Plague.* The term "fowl pest" includes two diseases known as fowl plague and Newcastle disease, but the latter is now generally called fowl pest. Newcastle disease and fowl pest are synonymous.

These diseases are highly infectious and extremely dangerous virus diseases which in their acute forms may cause heavy and rapid mortality.

Both diseases are notifiable in accordance with the provisions of the Fowl Pest Order of 1936.

The first recorded outbreak of fowl pest—*i.e.*, Newcastle disease, occurred at Newcastle-on-Tyne in 1926, hence its name.

In 1933 an outbreak occurred on a farm in Hertfordshire, but all the birds were slaughtered and the disease did not spread to other farms.

No further outbreak was reported until February 1947, when the disease was confirmed in Somerset and quickly spread to other parts of the country, by the movement of live birds through markets and by dealers. Enquiries showed that the source of infection was unboiled swill containing the offal of birds imported from European countries where the disease was rampant.

The position became so serious that the Fowl Pest Order of 1936 was amended to ensure more effective measures of control. The principal provisions of the amended Order are as follows:—

1. Every person having in his possession or under his charge any poultry, or the carcase of any poultry, which is affected or suspected of being affected with fowl pest shall, with all practicable speed, give notice of the fact to the local police or a veterinary officer of the Ministry of Agriculture.

2. A veterinary surgeon who examines any poultry, or the carcase of any poultry, and suspects that the poultry or carcase is affected with fowl pest shall, with all practicable speed, give notice of the fact to a constable of the police force for the area wherein the poultry or carcase is.

3. A constable receiving any such notice shall immediately transmit the information by the most expeditious means to the

Veterinary Inspector appointed for the time being by the Minister to receive such information within the area wherein the poultry or carcase is

4. Prevent the access of poultry, or of any person (other than the person attending the poultry) to the premises or part of the premises on which any diseased or suspected bird or carcase is or has been kept.

5. Detain on the premises all poultry thereon and the carcases of any poultry.

6. Restrictions are placed not only on the premises where the disease is certified to exist and premises where there are poultry which have been exposed to infection, but also premises where the disease is certified to have existed during the previous twenty-eight days, as well as those on which, during the twenty-eight days, there were poultry which had been exposed to the infection of fowl pest.

7. The Ministry may cause to be slaughtered all affected birds or those suspected of being so and any poultry in contact with affected birds or exposed to infection in any way.

8. Compensation is paid only for any unaffected birds that have to be slaughtered.

In addition, there are restrictions on the marketing of live poultry and shows of live poultry, the boiling of swill is compulsory, while the importation of birds from countries in which the disease is present is prohibited.

Provisions of the Order are subject to amendment, and the reader is advised to seek information from his County Poultry Advisory Officer or from the police with regard to the provisions which may be in force at a given time.

The acute type of fowl pest will result in a high rate of mortality—up to 100 per cent. Turkeys, pheasants and other species of fowls are susceptible. Ducks and geese in close contact with affected poultry have usually remained healthy, but became infective to chickens after a period of three to four days and infectivity persists for three to four days (Asplin, 1947)

The symptoms of the acute type are as follows:—

Drowsiness, ruffled feathers, loss of appetite, greenish-yellow diarrhœa, rapid breathing accompanied by gurgling or rattling sounds, nervous twitching of head and neck, and partial

paralysis of wings and legs may be seen There may be a discharge from eyes and nostrils, egg production rapidly falls and the death rate may be very high

In mild cases, that is to say where the low type of the disease is present, the only symptoms may be a rapid decline in egg production usually accompanied by rattling sounds and symptoms normally associated with colds The mortality rate varies from nil to 10 per cent, but this type is dangerous because it can give rise to the acute type

Whenever there is a slump in egg production for no apparent reason, whether or not it is accompanied by any of the above symptoms, the poultry-man should report the matter to the local veterinary officer of the Animal Health Division of the Ministry of Agriculture or the County Poultry Advisory Officer

The virus is readily killed by heat, hence the importance of sterilizing all swill by boiling or steam-cooking The virus has been recovered from bone marrow and tissues of birds which have been kept under refrigeration conditions for at least six months This and other points are dealt with in a summary of the epidemic in England during 1947 in a paper read to the World's Poultry Congress, 1948 (Gordon, Reid and Asplin) and to the 14th International Veterinary Congress by Asplin, Gordon and Reid

A form of blood test is applied for the detection of infected birds It is called the hæmagglutination-inhibition test In many countries vaccines have been produced for the control of Newcastle disease Those which have been really effective, however, have been prepared from live virus, and have been associated with all the dangers in using this type of vaccine

Doyle and Wright (1950) described an inactivated vaccine against Newcastle disease and in 1952 Asplin[1] reported the results of preliminary experiments with a strain of Newcastle disease virus of low pathogenicity

Asplin found that "Chickens inoculated intranasally with this virus either developed mild respiratory symptoms or failed to show symptoms Chickens vaccinated when less than seven days old were immune for four or five months as judged by their failure to develop symptoms when challenged with virulent

[1] *The Veterinary Record*, Vol 64 page 245

virus Growing chickens or adults developed a more durable immunity

"Vaccine applied by wing web stab gave unreliable results Most vaccinated fowls whose H I titres had fallen to 10 or less were found to excrete virus in their fæces for a period following challenge"

There were few outbreaks in the early part of 1950, but in October of that year the low or sub acute type of the disease appeared in Suffolk and quickly spread to other areas

It is this type of the disease that persists, the greatest incidence being in the winter months, followed by relatively few outbreaks during the late spring and summer In 1960, however, this pattern was not followed, there were numerous outbreaks in the spring and summer, some involving large farms on which thousands of birds were slaughtered

The acute form appears to have been eradicated, no outbreaks have been reported in recent years

Owing to the continuance of sporadic outbreaks of the sub acute type, many have urged that the slaughter policy be abandoned in favour of vaccination They believe that this form of the disease must now be regarded as endemic, that the present policy is ineffective A survey by the Ministry of Agriculture failed to disclose widespread latent infection In view of the large number of outbreaks in 1959 60, the Minister of Agriculture appointed a Committee of Enquiry into fowl pest with wide powers to seek information, both in this country and overseas, with regard to the control and other aspects of the disease

The report of the Committee is not available at the time of writing

It is not without significance that the increase in outbreaks of fowl pest has coincided with the growth of the broiler industry High density of chick population in large groups under conditions prevailing on broiler plants is favourable to the spread of infection Some believe that extractor fans play a part in the dissemination of this and other diseases

Restriction of movement of live birds now enforced in certain areas with a view to preventing the spread of the disease seriously interferes with the business activities of breeders and hatcheries, but until veterinary authorities are satisfied that

other measures of control can safely be introduced it is incumbent on all concerned to comply fully with the provisions of the Fowl Pest Order.

Since the first outbreaks of fowl pest occurred in 1947, 14,106 outbreaks were reported, 17,176,592 birds slaughtered and about £13,500,000 paid in compensation to the end of 1960

Fowl Plague The symptoms of fowl plague, which may also affect turkeys, ducks, geese, pheasants, guinea-fowl and peafowl, and many wild birds, resemble those of acute fowl cholera Some birds are found dead without having shown symptoms Usually, however, the affected birds are dejected, refuse food, the feathers are ruffled, and in some cases there is a discharge from eyes and nostrils The incubation period is usually from three to five days and mortality may be as high as 100 per cent

The disease is usually spread by food and water contaminated with the discharge and droppings of affected birds High and rapid mortality in the flock should cause the disease to be suspected and the poultry-man should at once conform with the provisions of the Fowl Pest Order (see p 696).

Fowl plague is not known to be present in Great Britain

Fowl Paralysis, Leucosis, Lymphomatosis Fowl paralysis was first reported in this country in 1929, but it is probable that it had long existed to some extent in our flocks, losses being attributed to such complaints as rheumatism and cramp

In 1930–31, however, deaths became more numerous, and in subsequent years the disease assumed epidemic proportions, reaching its peak about 1936–37.

While losses among flocks in which symptoms of true fowl paralysis of leg, wing, neck and crop were widespread, increasing mortality was arising from lymphomatosis This is referred to as visceral lymphomatosis, and is due to the abnormal increase in white cells causing tumours in various internal organs

Coinciding with mortality from the above conditions, blindness became more prevalent. In many birds the pupil of the eye, instead of being circular, was irregular, often "fading" into the white. In others the iris became cloudy or white and

had the appearance of cataract. This condition is described as infectious iritis or ocular lymphomatosis.

At the same time some individuals were affected with enlargement of the bones (osteopetrosis), particularly those of the shanks, which became enormously swollen, while other birds showed evidence of anæmia (leukæmia) accompanied by progressive loss of weight and finally death.

For many years all these conditions were considered to be different manifestations of the same disease and were collectively

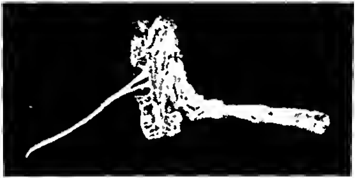

Photo · J. E. Wilson

FIG. 274.—FOWL PARALYSIS: AN ADVANCED CASE
Note the massive enlargement of the left nerve (of the bird) compared with the right nerve which is normal.

referred to as the avian leucosis complex or lymphomatosis, which thus comprised:

(1) neural lymphomatosis (fowl paralysis);
(2) visceral lymphomatosis (lymphomatous tumours);
(3) ocular lymphomatosis (eye form);
(4) osteopetrotic lymphomatosis (bone form);
(5) leukæmia.

A great many other terms were applied to the above conditions, believed to have a common causal factor.

The above classification resulted in the greatest confusion, and has been responsible for much misunderstanding, not only among breeders and their customers but also in veterinary science.

For example, for many years different views were expressed with regard to egg transmission of the disease. Hutt and Cole considered that if egg transmission did in fact occur it was of

relatively slight importance compared with exposure to infection early in life

Waters and his associates expressed an opposite view, and it was not until it was realized that the former were working with neural lymphomatosis or fowl paralysis and the latter with visceral lymphomatosis that these views could be reconciled

It is now accepted that the previous classification is no longer tenable, because far from being one there are four,

Photo Modern Poultry Keeping

FIG 275 —FOWL PARALYSIS A TYPICAL CASE OF FOWL PARALYSIS

Note the clutching claw of the bird's right foot which is held forward The left wing is also affected

possibly more, different diseases in the group, moreover, resistance to one does not necessarily imply resistance to any other

Avian leucosis is a neoplastic or cancer-like condition resulting from abnormal multiplication and dispersion of certain types of blood cells which either cause gross enlargement of the various internal organs (diffuse form) or tumour-like growths (discrete form)

The reason for the cells behaving in this manner is not understood Research is constantly proceeding, but the problem is as complicated as that of cancer in man The opinion, however, is that viruses are responsible

Leucosis is responsible for so-called big-liver disease and the

enlargement of the spleen, kidneys, heart and other organs in greater or lesser degree.

Pathologists subdivide the disease into three groups (*a*) lymphoid leucosis, (*b*) myeloid leucosis, (*c*) erythro leucosis, depending on the blood cells involved. Lymphoid leucosis is by far the most common disease, being responsible for about 80 per cent of the cases of leucosis. This form is the cause of big-liver disease.

Photo *Modern Poultry Keeping*

FIG. 276.—FOWL PARALYSIS: THE DROPPED WING—A COMMON SYMPTOM OF FOWL PARALYSIS

Myeloid leucosis results in soft, whitish tumours in breast bone, ribs and other bones and also in enlargement of liver and spleen.

Erythro leucosis is the least common type. It causes enlargement of liver and spleen, which become abnormally dark in colour, soft and readily rupture.

Subdivision of leucosis is of value mainly to the veterinary surgeon. It is not a matter of primary concern to the poultryman. Leucosis is most commonly seen in birds from about four months to eighteen months old.

Leucosis, or as it is still frequently referred to in literature, visceral lymphomatosis, may be transmitted through the egg,

but according to Burmester and Waters (1955) the importance of egg transmission lies not in the disease which may or may not occur in chicks hatched from infected eggs, but in the disease which is transmitted by direct or indirect contact from chicks which hatched from infected eggs to chicks which hatched from eggs of hens that have had no experience with the virus"

In other words, chicks from infected eggs may spread infection to susceptible chicks from non infected eggs

Research has demonstrated the infectious character of leucosis Infection occurs mostly among chicks during the brooding stage, therefore the more effectively they can be isolated for the first three or four weeks, the lower will be the incidence of the disease

Isolation of young chicks is the most effective and practical method of reducing losses from this disease Chicks should be brooded as far as practicable from growing and adult stock, and care should be taken to avoid carrying into the brooder house sacks, feed troughs and other appliances which may contain infective material

Fowl paralysis is a disease of the nerves It is now thought (Campbell, 1954) to be a chronic inflammation, possibly caused by a virus resulting in enlargement of various nerves and consequently paralysis of the part concerned

Birds affected with leucosis usually mope and show the common symptoms of ill health, although some may lay to within a few days of death Bright green diarrhoea, emaciation and anæmia frequently occur Symptoms are not, however, characteristic

In cases of fowl paralysis typical symptoms are commonly seen They will depend on the nerves affected, for example, paralysis may appear in one or both legs or wings, in the neck or crop

Usually one leg (or wing) is affected at the outset, the first symptom being slight limping Later the leg (or wing) becomes completely paralysed Frequently the bird may drag a leg or hold it in a forward position Paralysis of the neck muscles may result in the neck becoming twisted

There is no evidence that fowl paralysis is transmitted through the egg It differs from leucosis in this respect, but in common

with leucosis it appears to spread by contact during the brooding period. The younger the chicks, the greater their susceptibility to infection. Therefore they should be isolated at least up to three or four weeks of age.

Similarly, the bone form has been removed from the leucosis group of diseases. Osteopetrosis is comparatively rare; it is not of economic importance, and its cause is obscure.

Photo: Modern Poultry Keeping

FIG. 277.—OCULAR LYMPHOMATOSIS: THE PIN-POINT PUPIL COMMONLY SEEN IN BIRDS

Ocular lymphomatosis or iritis (grey eye) is no longer regarded as a manifestation of leucosis. Whether there is any association with paralysis is uncertain, and the cause has not been determined. Many workers believe that it is infectious.

While birds showing split or running pupils, pin-point pupils, "grey eye" and other defects of the eye should be culled, it seems desirable to point out that birds having pale-coloured eyes, always provided they are structurally perfect, may be healthy and can produce healthy progeny.

Ball and Cole, Department of Poultry Husbandry, Cornell University Agricultural Experimental Station, studied the relationship between the iris colour of the dam and the mortality of her progeny. Data from the investigation were based

The leukæmic or blood form of the disease is fairly common and is caused by the lymphoid or tumour cells invading the blood stream. This results in leukæmia.

Distinction between the different manifestations of the leucosis complex and other conditions commonly found in poultry is often difficult and requires laboratory investigation. It must not be assumed that all birds showing symptoms of paralysis are affected with the disease, and whenever a number of suspected cases occur a poultry pathologist should be consulted.

Although chicks are usually infected with leucosis and fowl paralysis early in life, symptoms in the case of leucosis are most commonly seen as the birds approach maturity and during their first laying season. Fowl paralysis is most prevalent in growing stock between three and seven months old, but in recent years there is a tendency for cases to occur in younger birds between four and eight weeks old, particularly when intensively reared.

In the light of present knowledge, control of this group of diseases must depend on sound methods of breeding and general management, including isolation of young chicks.

By selective breeding it is possible to establish resistant strains, as the work of Hutt and his associates at Cornell University has shown, but to be successful this method of tackling the problem entails pedigree breeding, very effective control, exposure to infection to test for resistance, a long-term and costly breeding programme.

The breeder will be on firmer ground if he selects stock for sound general health, if he breeds in family groups and keeps full control of new stock that may be introduced until it has proved high resistance to infection of these diseases.

How far a breeder could go in rejecting families according to the incidence of leucosis or fowl paralysis will depend, of course, on individual circumstances, but it is wiser to select for good health than to make specific selection for resistance to these diseases.

No drugs or vaccines have been discovered for the prevention of leucosis or fowl paralysis.

The diseases are not nutritional as the term is generally understood, but this does not imply that malnutrition may not be a predisposing factor, as also may coccidiosis, internal parasites and environmental conditions.

Epidemic Tremor (Encephalomyelitis) Sporadic outbreaks of this disease are reported Long recognized overseas, it did not occur in Britain until about 1953 In recent years the incidence of the disease has increased

Knowledge of this disease at the moment is slight, but it may be egg transmitted by carrier birds It frequently disappears after one or two batches of chicks have been affected, since adults develop immunity and pass this to their progeny Outbreaks are often confined to the eggs from a particular flock

The disease can probably also be transmitted by contact from chick to chick, but the mode of spread under natural conditions is not understood

The disease is one of considerable economic importance, in large scale chick productioo, as in broiler growing, mortality may be high

Symptoms are most commonly seen in chicks of two to six weeks old, but they may express themselves in chicks about a week old and in growing stock It is, however, primarily a disease of young chicks

Affected chicks show unsteadiness in movement accompanied by slight tremor of head and neck As the disease progresses, tremor increases, twisting of head and neck occurs and legs become paralysed

The disease cannot be distinguished by field examination from certain symptoms arising from fowl pest and crazy chick disease Live specimens must be examined in the laboratory, but in view of the possibility of fowl pest being responsible for the symptoms, a veterinary surgeon should be consulted before birds are sent to a laboratory

There is no treatment for this disease All chicks showing symptoms should be killed

Infectious Bronchitis This disease, common in the U S A, may be more prevalent in this country than reports indicate, for the symptoms are indistinguishable from those of colds and other respiratory diseases

In young chicks mortality may exceed 50 per cent In adult birds few losses occur, but there is a sudden fall in egg production and the laying of grossly misshapen, badly shelled eggs

Most outbreaks in Britain have occurred among laying

flocks. The disease is comparatively rare in chicks, but this may be due, as Chu points out (1958), to outbreaks among young birds being of so mild a type that they are not recognized.

There is no evidence of egg transmission. Infection is spread by the virus passing from bird to bird and in houses not efficiently disinfected. Infection may be carried over from one batch of birds to another.

Vaccines, widely used in the U.S.A. and Canada, are not available in this country. Control of the disease can be effected by depopulation of the houses, cleaning and disinfection of plant and equipment.

Infectious Synovitis. This disease, first reported in the U.S.A. in 1954 by Olson *et al.* and in Britain in 1959 by Carnaghan, occurs principally on broiler plants. In the U.S.A. the disease is widespread in broiler-growing areas.

Symptoms may become apparent when the chicks are about six weeks old. Mortality may not exceed approximately 10 per cent, but a high proportion of the survivors are likely to be downgraded on account of poor carcase quality.

The majority of affected birds show swellings of the joints of the foot and hock and the tendon sheaths between foot and hock. The swellings contain a thick grey or yellow fluid.

The conditions under which broiler chicks are reared appear to make them susceptible to this disease.

" The agent isolated by Carnaghan appeared to be sensitive to streptomycin and resistant to penicillin, and in chick experiments chlortetracycline in the drinking water at the level of 600 mg./gal. (approx. equivalent to 200 gm./ton) was shown to prevent the development of the disease when given five days after infection.

" Furazolidone has also proved effective in field trials when given at a level of 100/200 gm./ton (Cosgrave 1957) " [1]

Fungoid Diseases. *Aspergillosis or Brooder Pneumonia.* Aspergillosis is frequently described as brooder pneumonia. The latter term is misleading because it does not distinguish between pneumonia arising from other causes.

Aspergillosis is a specific disease due to a common fungus (*Aspergillus fumigatus*), frequently present in damp litter and mouldy food.

[1] Gordon, British Vet. Assn. Meeting, 1959.

The fungus establishes itself in the windpipe, air-sacs and lungs, which show yellowish-white nodules. Young chicks are most susceptible to the disease, but it may affect older birds.

The symptoms may be confused with those of other chick diseases. Affected chicks mope, the feathers are ruffled, the wings droop. There is diarrhœa, loss of appetite and loss of weight. Later the chicks become very weak and are unable to stand. Breathing is rapid, and a rattling or snoring sound

Photo J. E. Wilson

FIG. 279—FAVUS OR WHITE COMB

can be heard if chicks are held to the ear. This is due to air passing through the accumulation of mucus in the respiratory passages. There is no treatment for the disease. Affected chicks should be killed and the bodies burnt.

The disease should be prevented by attention to sanitation. Care should be taken to avoid mouldy litter or food, and to keep the litter dry. The trouble may arise from spilling water when filling the drinking-vessels, or failure to keep the food-troughs clean, particularly when feeding wet mash.

Favus or White Comb. This disease, which seems to be very rare, is caused by a fungus that attacks the comb, face and

wattles, but if neglected will spread to the feathered parts of the body

The disease first appears as whitish-grey areas on the comb and face Later these areas may coalesce

The affected parts become encrusted, and have an unpleasant odour like mouldy cheese In advanced cases the feathers are dry and brittle and break off, leaving bare patches The birds become emaciated and may die

In the early stages the disease is readily cured The affected parts should be washed with warm, soapy water containing 2 per cent of reliable coal-tar disinfectant, and should then be dressed with coal-tar or sulphur ointment every two or three days

The house should be thoroughly disinfected and the litter renewed Care should be taken when handling affected birds, as the disease is transmissible to man

Protozoan Diseases. *Coccidiosis* This is one of the commonest diseases of chicks and growing stock Years ago it was responsible for serious losses among chicks, the death rate in many outbreaks being extremely high Today drugs are widely used for the prevention and treatment of this disease They are so effective that it is no longer a major hazard in chick rearing, but outbreaks among broiler chicks may result in serious financial loss by downgrading of the carcases

Coccidiosis is caused by protozoan organisms known as coccidia They are microscopic parasites of which there are many species Certain species produce no symptoms, some have a detrimental effect on the health of the stock but do not cause death, while others, if outbreaks are permitted to run their course, may be responsible for high mortality

Coccidia are known as "host-specific" parasites—*i e*, the species or types responsible for disease in fowls will not affect other animals, such as cattle and rabbits, and the coccidia affecting these animals will not affect fowls This applies even to species of birds, for example, the coccidia harmful to turkeys, geese and ducks will not affect fowls

Other birds and animals may, however, act as mechanical carriers of the types of coccidia affecting poultry

The life-cycle of coccidia is rather complicated, various forms of the parasites being produced in the course of it

A point of outstanding importance to the poultry-man,

however, is the fact that the form in which the parasite is passed in the droppings—the so-called oocyst—is incapable of causing infection in other birds until it has "sporulated" or "ripened", a process which under favourable conditions of temperature and moisture may be completed in forty-eight hours.

If, therefore, *the life-cycle is broken at this point* by renewal of the litter and removal of the birds to fresh ground, *the* disease is controlled.

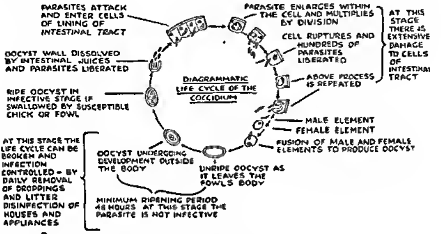

FIG. 280.—COCCIDIOSIS: DIAGRAM SHOWING CYCLE OF INFECTION

Before effective drugs were discovered renewal of the litter at forty-eight-hour intervals was commonly practised. On some farms the young chicks were housed in folds which were moved to fresh ground daily. These measures are rarely applied to-day, because drug treatment is more effective and simpler.

Unless drugs are used or reinfection prevented, the birds will continue to pick up sporulated oocysts in food, water and from the litter. Constant reinfection results in a massive build-up of the parasites, often resulting in the death of the host.

When a bird swallows a ripe oocyst the tough envelope with which this latter is surrounded breaks down, liberating eight so-called sporozoites, which immediately penetrate the walls of the digestive tract, and eventually destroy the cells and cause great injury.

In practice these oocysts are swallowed in great numbers, and since each is capable of producing, *by simple division* within the digestive tract, 500–1,000 other forms, it will be realized that enormous damage may be done.

The parasites are so minute that it is extremely difficult to prevent infection in some degree, even by adopting laboratory methods. The oocysts can be carried on the hands and boots of the attendants, on food-sacks and utensils, on the feet of wild birds and animals, and they can be air borne.

Coccidia are very widely distributed in nature. Few birds are completely free from the parasites, which can be regarded as normal inhabitants of the digestive tract. When present in small numbers they do no apparent harm; when, however, their number is excessive, the birds show symptoms of coccidiosis in greater or lesser degree.

Photo J. E. Wilson

FIG. 281.—ACUTE CÆCAL COCCIDIOSIS
Note enlargement of "limb" with blood-stained contents

Cæcal Coccidiosis. The cæcal form of coccidiosis affects chicks from a few days up to about eight weeks of age, after which they are very resistant to this type of the disease.

Cæcal coccidiosis is caused by *Eimeria tenella*. This type of coccidia differs from others in that the whole of its life-cycle within the bird is spent in the cæca. In common with other types, oocysts are passed in the droppings and must sporulate before they become infective.

In very acute cases a chick may show no symptoms, being found dead in the brooder. This may occur with individual chicks, but, taking the brood as a whole, the symptoms are sufficiently characteristic to enable the practical man to recognize the disease, or at least to suspect it, and then to adopt precautionary measures pending expert advice. It is essential to take the necessary steps to control the disease immediately the chicks show symptoms of it.

Affected chicks stand about with eyes closed, drooping wings and the head drawn into the body The feathers are ruffled; the birds have an anæmic appearance The most characteristic symptom, however, is the presence of blood in the droppings, which first appears between the fourth and fifth day following ingestion of sporulated oocysts

In a rough post-mortem examination carried out on the farm, the cæca will be found thickened and swollen and the contents to consist of yellowish, cheesy material mixed with more or less blood—varying from red to brown in colour or in acute cases pure blood and blood-clots

While several very effective drugs are now available for the control of coccidiosis, one of the earliest to be employed was one of the "sulpha" group—Sulphamezathine

Horton-Smith and Taylor at the Ministry of Agriculture's Laboratory first demonstrated the value of this drug

The drug is now available in powder form for inclusion in the mash for the treatment of the disease (it should not be continuously used as a means of prevention), but it is more commonly used as a 16 per cent solution of the sodium salt of sulphamezathine, of which 2 oz (4 tablespoonfuls) are added to each gallon of drinking-water This will make a solution of 0 2 per cent of the drug in the drinking-water

Treatment should be introduced immediately symptoms are noticed, and should be continued for not more than five days

An alternative method is to give the drug for three days, water only for two days, followed by a further three days of medicated water The 3 2 3 schedule should not be continued, that is to say, two periods each of three days with an interval of two days between them are sufficient

A remarkable feature is that chicks that have recovered from the disease as a result of treatment with Sulphamezathine become immune to subsequent infection

Sulphamezathine is of no value in the prevention of the disease, and in no circumstances should it be given as a precautionary measure The drug itself does not produce immunity It is the coccidia themselves that produce this the drug controls the severity of the attack by inhibiting reproduction of the parasites in the later stages of their life-cycle In other words, a mild attack of coccidiosis which the drug ensures,

protects the birds from subsequent attacks in much the same way as inoculation.

In view of this, the litter should not be renewed.

It should be borne in mind that the drug is toxic if used for long periods.

The drug is stable in sodium solution and may be kept in stock for immediate use in the event of an outbreak.

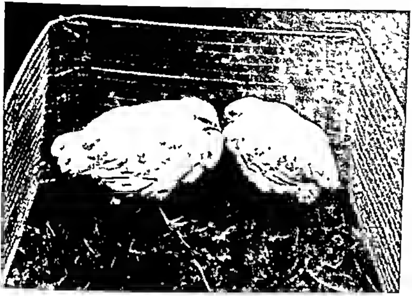

Photo Modern Poultry Keeping

FIG. 282.—COCCIDIOSIS IN GROWING STOCK

These birds are affected with coccidiosis and show typical symptoms of the disease

In more recent years other "sulpha" drugs have been employed in the treatment of coccidiosis, and in some cases as a means of preventing the disease.

The most effective drug of this type is sulphaquinoxaline. "The great advantage lies in the relatively low concentrations that are necessary to control cæcal coccidiosis and permit the development of resistance. No toxic effects arise as a result of short term treatments with low levels of the drug in the food" (Horton-Smith, 1951).

The drug is now available as a premix which is mixed with the mash to give 0·05 per cent of the active drug in the diet. In the event of an outbreak, the drug should be given for a period of seven days. Alternatively, the intermittent method of treatment may be used as advised when using sulphamezathine.

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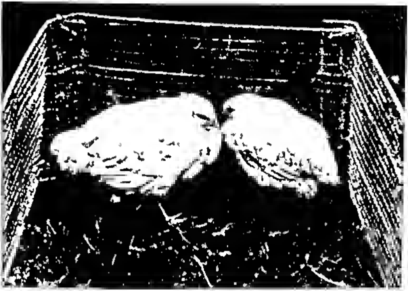

Photo Modern Poultry Keeping

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Sulphaquinoxaline may be obtained as a 10·32 per cent solution for use in the drinking-water. This solution is added at the rate of 2 oz. to each 3 gal. of water, which provides a 0·045 per cent solution. This should be given on the same basis as sulphamezathine.

Sulphaquinoxaline may be used as a preventive. For this purpose it is fed at an 0·0125 per cent level continuously for the first six or eight weeks.

Recent work at the Ministry of Agriculture's Laboratory has shown that the addition of extremely small quantities of pyrimethamine to either sulphamezathine or sulphaquinoxaline has a synergistic effect, so much so that even when "sulpha" drugs are used at one-tenth of the normal dose they are effective in the control of coccidiosis. Such combinations are not yet available.

Later work suggests that pyrimethamine is relatively toxic for chicks (Stockdale 1958, Lucas 1958).

Nitrofurazone, a drug not of the "sulpha" group, is also extremely effective in the treatment of coccidiosis and, in common with sulphaquinoxaline, may be given as a preventive when the chicks are exposed, or believed to be exposed, to infection. For the treatment of outbreaks 0·022 per cent of the drug is used in the food for seven days or 0·011 per cent for ten days, where the chicks are exposed to heavy infection. For the prevention of cæcal coccidiosis nitrofurazone is fed at the level of 0·005–0·01 per cent continuously to chicks from day to eight to twelve weeks old.

When treatment with the above drugs is employed, renewal of the litter is unnecessary.

After the chicks leave the brooder-house following an outbreak it should be thoroughly cleaned and then disinfected with a 4 per cent solution of washing-soda in hot water, and finally sprayed with a 10 per cent solution of household ammonia. The house should be thrown open to dry and air before being used again.

It should be understood that no drug will guarantee complete freedom from coccidiosis. Occasionally outbreaks occur even when all practical measures have been taken to prevent them, but provided treatment with one of the above drugs is introduced promptly, the outbreak will be controlled and losses reduced.

When symptoms of coccidiosis are seen among chicks receiving a drug at preventive level, the dose should be increased to the curative level for not more than seven days Alternatively, another drug may be used at the curative level

The action of sulphaquinoxaline and nitrofurazone is similar to that of sulphamezathine Chicks that have recovered from an attack as a result of treatment with these drugs are resistant to subsequent infection

Nicarbazin is one of the latest drugs to be used for the prevention of cæcal coccidiosis It is given continuously at the rate of 0 0125 per cent in the food If necessary it can be fed until the pullets are approaching maturity

Nicarbazin should not be given to laying stock because it results in a high incidence of mottled yolks It will also result in birds that normally produce brown shelled eggs laying white-shelled eggs The drug has an adverse effect on hatchability

Nicarbazin, nitrofurazone, amprolium and zoalene are now considered to be the most effective drugs for the prevention of the disease The two latter drugs are of recent introduction They are becoming widely used, and may replace the two former A mixture of nitrofurazone and furazolidone at 0 005 and 0 008 per cent respectively has also given good results

But new drugs are under test, some may prove superior to those at present in common use

For treatment the "sulpha" drugs appear to be the most effective They should be given on the 3 2 3 schedule already mentioned

Care should be exercised when using all the above and, of course, other drugs to ensure the correct dosage An overdose can produce toxic effects, and may cause high mortality Directions for use should be followed

Cases of so called hæmorrhagic disease have been reported among chicks receiving "sulpha" drugs, but there is no evidence that they are solely responsible for this condition, since these drugs are extensively used while outbreaks of hæmorrhagic disease are rare

It would appear that other factors are at work

Duodenal Coccidiosis Two types of coccidia are mainly responsible for duodenal coccidiosis, namely, *Eimeria acervulina* and *E necatrix* While both types may affect young chicks,

duodenal coccidiosis usually occurs among growing and adult stock. It usually takes a chronic form, in which actual deaths may not exceed, say, 10 per cent, but 50 per cent or more of the flock may be so seriously affected that they become culls

Affected birds are unthrifty, and stand about with drooping wings They are anæmic, have poor appetites and show progressive loss of weight Blood is not seen in the droppings

One of the drugs recommended for the treatment of cæcal coccidiosis should be used at the same strength and for the same period for the duodenal type

Nicarbazin is recommended for prophylactic medication against this type of the disease caused by *E necatrix*, but it is less effective for intestinal coccidiosis due to *E acervulina* and *E maxima*

The "sulpha" drugs are believed to be the most effective against these species

Unfortunately, symptoms are not so marked as in acute coccidiosis, and serious damage may be done to the digestive tract before the disease is diagnosed No drug can replace damaged tissue, and if the latter is extensive the birds will continue to lose condition, even though drug treatment has effected control of the outbreak

Some antibiotics are of value in countering the effects of coccidiosis and to some extent in controlling the disease Terramycin fed at high level appears to give the best response Penicillin and streptomycin seem to have little effect for this specific purpose

Blackhead Blackhead is a protozoan disease that may be responsible for heavy losses among growing turkeys It is of little interest to the poultry-man although recently it has become more common among fowls A number of outbreaks have been reported among chicks

The disease responds to treatment with furazolidone (0 015 per cent of the food)

Since turkeys are frequently carriers of blackhead, they should not be run with hens The two classes of stock should not be reared together

Internal Parasites *Parasitic Worms* Parasitic worms are of economic importance to the poultry-keeper They may cause heavy losses in chicks and growing stock, in adult birds they

prevent normal assimilation of the food, and as a consequence have an adverse effect on egg production The parasites also lower the birds' resistance to other and more serious diseases

Worms in chicks and young stock are frequently responsible for retarded growth and mortality In adult birds, however, the effect of the parasites, unless the infestation is an exceptionally heavy one, is usually exaggerated There is no doubt that much nonsense has been written about worms in poultry Their presence in moderate numbers does not appear to be detrimental, and excessive numbers are usually an indication of lack of resistance of the stock

Many flocks are treated for worms merely because a few individuals are found to be heavily infested

Unless there is evidence that infestation is widespread—and this will be indicated by the condition of the flock as a whole—treatment may do more harm than good, since it may result in a drop in egg yield Further, it is useless to treat the birds unless they can be removed to fresh ground or be kept in total confinement If they remain on contaminated ground they quickly become re-infested

Good feeding, good sanitation, including attention to the land, will prevent worms becoming a serious menace to the health of a vigorous flock Only when the birds lack vigour and/or are kept under most insanitary conditions is worm infestation likely to affect their health

With young stock, however, considerably more care must be exercised, because they lack the resistance of adults

The Gape-worm At one time the gape-worm was responsible for heavy losses among chicks, particularly between two and four weeks of age It is rarely found in chicks over six weeks old

Few cases are reported nowadays, because infestation is prevented by rearing the chicks in confinement or on clean ground for the first six weeks

The worm establishes itself in the lower part of the windpipe, and occasionally in the smaller air-passages

The adult female worm is rather less than 1 in long, the male worm, about one fifth the size of the female, is attached to it, hence the parasites have a forked appearance When

removed or coughed up by the chick they are red, owing to their being gorged with the chick's blood

Symptoms may be seen when the chicks are about ten days old At first they develop a curious cough, sneeze and shake their heads in an effort to eject the parasites Later breathing becomes more difficult, the chicks stretch their necks, open their mouths and gasp They are very distressed, and eventually death occurs from suffocation, the worms blocking the wind pipe

The disease is so easily prevented that no poultry man should suffer losses from it

Should chicks be affected, it is advisable to treat all in the batch Treatment should not be confined to chicks showing symptoms

Inhalation of barium antimonyl tartrate as a dust is advised The chicks should be placed in a roomy box and the powder blown into it One ounce per 8 cu ft of air space in the container is adequate

Gape worms can be removed mechanically with a gape worm extractor or by means of a feather dipped in turpentine The feather should be turned several times when in the windpipe and then slowly withdrawn, when some of the worms will adhere to it The feather should be stripped of its barbs except at the tip

Hairworms Hairworms are small, thread like round worms of the Capillaria species One variety inhabits the crop, another the upper part of the intestines Their presence is easily overlooked by the layman when carrying out a post mortem examination

As with other species of worms, small numbers do little or no harm, but heavy infestation will result in loss of condition and even death Chicks and growing stock are usually more susceptible to these parasites than adult birds

Cæcal Worm As its name implies, the cæcal worm (*Heterakis gallinæ*) is found in the cæca or blind guts It may be regarded as a normal inhabitant of this part of the digestive tract, since it is estimated that 80 per cent of the birds in this country harbour this parasite

In ordinary circumstances the worms do no harm, and only when the infestation is an unusually heavy one should

tbe birds be treated. The worms are greyish-white in colour and about $\frac{1}{4}$–$\frac{1}{2}$ in. long. They are readily found when the cæca are cut open.

The Large Roundworm. It is estimated tbat this worm (*Ascaridia lineata*) occurs in about 20 per cent of the birds in this country. When large numbers are present serious harm can result particularly among growing birds.

The worms are found in the small intestine. They are white or yellowish-white, 1 to 4 in. long. They are passed in the droppings from time to time and are easily seen.

There are many other species of roundworms parasitic in poultry.

The poultry-man should realize that worms do not breed in the birds, nor are they inherited. Every worm must be picked up from the ground or litter, therefore prevention depends on keeping the birds in clean houses on clean land.

Tapeworms. Tapeworms differ from roundworms by the fact that part of their life-cycle occurs in intermediate hosts—slugs, snails, earthworms and flies—and it is by eating these that the birds become infested. Different species of worms have different intermediate hosts. In the hosts the worms occur in the cystic stage, which is a stage in development between tbe egg and the adult worm.

When the cysts are swallowed by the host, the larvæ or young worms are released, attach themselves to the mucous lining of the intestines and develop segments from the free portion of the neck. These segments are small near the head of the worm, but become wider and longer as the distance from the head increases. When ripe the segments are cast off into the intestines and are expelled in the droppings. The segments are full of eggs, each capable of developing into a mature worm.

Tapeworms are of many different species. Some are quite large and easily seen, others are small and difficult to detect by the layman. The smallest tapeworm, *Davainea proglotina*, which infests the duodenum, was at one time a relatively common cause of economic loss. To-day few outbreaks occur; indeed, this and other species of tapeworm are of less importance than formerly, mainly as a result of the industry turning to intensive methods of housing.

Symptoms of Worm Infestation The presence of worms in the droppings is, of course, conclusive evidence that the birds are infested, but it is not conclusive evidence that they are seriously infested

When the infestation is a heavy one there is loss of condition, loss of appetite, dullness of plumage, and paleness of face, comb and wattles Persistent diarrhœa is usually present

In chicks the presence of worms results in arrested growth, emaciation, and perhaps heavy mortality

Large numbers of worms in young and adult stock may be responsible for depraved appetites, the birds eating litter, droppings, coarse grass, and so on The waste matter produced by the parasites may have profound constitutional effects, as seen in animals

Treatment for Roundworms Recently introduced piperazine compounds, in which the active principle is piperazine adipate, piperazine citrate or piperazine carbon disulphide, have been found very effective in the eradication of roundworms (ascaridia)

Horton-Smith and Long (1956) showed that when given in single doses varying from 100 to 500 mg per kilo body weight these drugs completely eliminated adult roundworms (*Ascaridia*) In these experiments oil of chenopodium and phenothiazine were only 4 5 per cent and 39 per cent respectively as effective Carbon tetrachloride was as efficient as piperazine compounds, but the latter are far less toxic than the former

Piperazine compounds are available under proprietary names Manufacturers' directions should be followed

Phenothiazine is commonly used in treating flocks for caecal worms It is the most effective vermifuge against this species

Phenothiazine is given in the food at the rate of $\frac{1}{2}$–1 gram per bird or $\frac{1}{3}$ gram on three consecutive days It is obtainable as a premix and in tablets It can be given for all species of roundworms

When using any of the above-mentioned drugs it is unnecessary to starve the birds prior to treatment or to give purgatives following their administration

Birds should be confined to the houses during treatment, and should then be removed to fresh ground Litter should be

replaced to get rid of the worm eggs Routine treatment of pullets prior to their being housed in permanent quarters is carried out on many farms

Carbon tetrachloride in 1–2-c c doses is available in capsule form for individual treatment, but although effective, it is not so satisfactory in field practice as other drugs It is doubtful whether treatment for hairworms is justified It should not be attempted unless advised by a veterinary expert

Treatment for Tapeworms Among the many drugs that have been recommended are powdered areca nut at the rate of 3 grains per bird, kamala in 1-gram doses and thymol 1 grain per bird

These old remedies are of little value, because in so many cases they do not remove the head (scolex) of the parasites Unless treatment gets rid of the head, the worms continue to develop Moreover, the use of some drugs, often preceded by a period of starvation, frequently had adverse effects on the general condition of the birds, so much so that treatment did more harm than good

Kerr (1952) and Edgar (1956) have shown that a compound of tin, di *n* butyl tin dilaurate, or as it is sometimes called butynorate, or tinorbat, is an effective and safe drug for the removal of common species of tapeworm

Edgar found that the compound was highly effective in the removal of six common species from field infected hens when administered in the feed at the rate of 500 mg per kilo or as a single 125 mg dose by capsule

The compound is now available commercially in a form specially prepared for the treatment of poultry It may be obtained from chemists dealing in veterinary medicines

As tapeworms are not directly infective, however, steps should be taken to deal with the intermediate hosts

With this object in view, poultry manure should not be stored in the vicinity of the houses If the land is wet and low-lying, it should be drained

To get rid of slugs and snails from the runs, the ground should be treated with copper sulphate For dry ground a ½ per cent solution should be used at the rate of 130 gal per acre, for wet ground a 2 per cent solution at the rate of 80 gal per acre

Another method is to use a mixture of 1 part powdered copper sulphate and 4 parts sand, and apply at the rate of ¼ cwt. of copper sulphate per acre when the ground is damp

This treatment should be carried out in the summer months, when mature slugs and snails are found

Control of Flies. Since flies may be the intermediate hosts of some species of tapeworms, and may be the means of spreading these and other diseases, steps should be taken to destroy them

Fortunately, D D T (dichlorodiphenyl-trichloro-ethane) in minute quantities is toxic to them, and when applied to the walls, roof and other surfaces of poultry-houses, it retains its lethal qualities for long periods By this means the fly nuisance in and around poultry-houses and farm buildings may be reduced to negligible proportions

Observations have shown that a 3 to 5 per cent spray at the rate of 1 gal to 1,600 sq ft will kill 80 to 90 per cent of flies and that the spray remains sufficiently effective to kill flies several months after its application A 1 per cent spray on manure heaps was found to be most effective (Gordon, 1949)

In addition to D D T, solutions of benzene hexachloride (B H C), piperonyl butoxide and pyrethrins applied by means of aerosol dispensers and electrically heated diffusers will destroy flies, lice and mites

It should be emphasized that from the practical standpoint treatment for worms cannot be regarded as satisfactory. The poultry-man should concern himself with preventing infestation by building up the resistance of his birds by sound methods of breeding and feeding and by keeping his flock under sanitary conditions

External Parasites. *Lice* External parasites of poultry *rarely cause mortality, but they are responsible for great* financial loss, because they retard the growth of young stock, lower the condition of adults and result in loss of egg production

Insect pests are more troublesome during hot weather, when they multiply rapidly, but, winter or summer, it is never wise to assume that the birds are free from them The stock should be examined for lice at frequent intervals throughout the year, and the perches, perch sockets and slatted floors for red mites

The effect of lice on poultry has been exaggerated A light infestation does no apparent harm, in fact, some very prolific

layers harbour the parasites in large numbers But they can cause trouble among young stock Lice may carry disease, which is sufficient reason for getting rid of them

There are several species of lice parasitic on poultry, some attack the head and neck, some the wings, others the body, especially in the area of the abdomen and tail, but, since the methods of eradication are similar, it is unnecessary for the practical man to study the separate species

The body-louse is the commonest species It is found around the vent and tail It is about $\frac{1}{7}$ in long, pale yellow in colour with dark spots When the feathers are parted, the lice may be seen running over the surface of the skin The eggs or " nits " are laid in clusters at the base of the feathers

The wing-louse establishes itself in the primary and secondary feathers of the wing, the feathers having a jagged or serrated appearance

The head louse is most injurious to young chickens, but is rarely found among artificially reared broods

Treatment for Lice Treatment is so simple and effective that no one should permit his birds to be over run with these pests

An application of a 40 per cent solution of nicotine sulphate (perch paint) to the perches about half an hour before dusk will rid the birds of these pests The heat of the birds' bodies evaporates the solution, and the fumes destroy the lice and nits As some of the latter may survive it is advisable to examine the birds in the course of a week and repeat treatment if necessary

One pint of nicotine sulphate solution is sufficient for 250 ft run of perch

In slatted floor houses the solution may be applied to every alternate slat, or temporary perches may be used

For individual treatment one or two spots (not more) of the solution should be applied to the breast feathers or abdominal fluff under the vent, or the solution may be applied to the hock with a small camel hair brush, making a mark about as large as the bristles These two latter methods are employed in laying battery houses

The most modern method of dealing with external parasites, however, is by aerosol dispenser units which distribute insecticides and of course, disinfectants in an extremely fine mist

With this equipment the work is quickly and effectively carried out

In battery and deep litter houses pyrethrin compounds or B H C applied with dispensers will save much time compared with methods formerly employed Moreover, in addition to

Photo Gordon Fe b r (Sales) Ltd London

FIG 283—A MICROSOL ELECTRIC DISPENSER IN USE IN A BATTERY HOUSE

Mass treatment of insect pests and disinfection are speedily and effectively accomplished with an aerosol dispenser

freeing the birds from parasites, these insecticides so applied will destroy mites in their hiding places The mist penetrates cracks and crevices in houses and equipment

In broiler houses lice and mites (see below) can be readily controlled by B H C dusts—Lindane, Gammexane—applied to the litter at the rate of 3 lb per 1,000 sq ft, but in these houses aerosols have also proved most effective

In recent years an organic compound of phosphorus known as Malathion has been introduced It may be used as a spray or in powder form For dusting the litter 1 lb of 4 per cent Malathion per 40 sq ft is recommended For spraying walls,

nests and roosts a solution of 1 per cent Malathion should be used

Treatment of individual birds is now rarely practised

However, for dusting individual birds sodium fluoride, B H C, D D T pyrethrum preparations and Malathion are recommended, a "pinch" of the powder being distributed among the feathers, especially about the vent, tail and under the wings

Sodium fluoride is an irritant and poisonous Care should be taken to prevent its coming in contact with the attendant's eyes, nose and throat It must not contaminate the fowls' food or water

D D T is effective against lice, but not against red mites

For the treatment of head lice of chicks, a pinch of sodium fluoride should be worked down to the skin of the infested part Ointments are effective, but give the chicks a "smeared up" appearance

Red Mites Red mites, in common with other blood sucking parasites, may cause great mischief Unlike lice, they do not live on the birds, but only visit them to feed During the day these parasites secrete themselves in clusters wherever they can find seclusion in the vicinity of the roosting place Under the perches or slats and in the cracks and crevices near them are favourite resting places, but should treatment be delayed the parasites may be found in swarms in the door jambs, behind mash hoppers and nest boxes, and even under the roofing felt

The red mite causes great irritation, as it feeds on the fowl's blood while the birds are on the perches at night It prevents their obtaining proper rest, and the constant sucking of blood results in their becoming anæmic Consequently appetites are poor and the birds lose condition Heavy infestation by red mites may have fatal results among chicks and growing stock

The mites are about 1 mm in length, light grey or yellowish in colour, but red when gorged with the fowl's blood Their colour in the poultry house varies from bright red to bluish grey, depending on the stage of digestion of the blood As they always congregate in masses no difficulty is experienced in identification

The mites are easily destroyed Dressing the perches,

perch-sockets and cracks and crevices about the droppings-boards with paraffin or paraffin emulsion will kill them. But treatment with aerosols is advised as for lice.

Northern Fowl Mite. This parasite is far less common than red mite, but outbreaks are becoming more numerous. It has caused losses in broiler-plants and quite serious trouble in some deep-litter houses.

Northern fowl mites resemble red mites, but differ in habit from them in that they remain on the host day and night, but, of course, migration from bird to bird occurs, consequently the

Photo: Modern Poultry Keeping

FIG. 283A.—DEPLUMING MITE

parasites are also found in the roosts. For this reason it is advisable to dust the birds with a pyrethrum or B.H.C. compound and use a perch paint. If an aerosol spray is used it should be directed to the area of the vent where the mites congregate.

Depluming Mite. The depluming mite usually appears in the spring, and unless remedial measures are promptly applied the birds soon show large areas bare of feathers.

The mites live at the base of the feathers, which become dry and brittle and break off. The broken stubs have a characteristic bitten-off appearance.

Frequently the rump first becomes affected, and for this reason the bareness may be attributed to the male's treading. The trouble quickly spreads to other parts of the body, especially the neck. The skin of the bare areas may be inflamed.

This parasite is not only the direct cause of the loss of feathers, but owing to the irritation set up by the mites the birds may pluck their own and each other's feathers. Feather-plucking is commonly associated with infestation by this mite.

In the early stages of the disease local applications of oil of carraway ointment (1–5) or a mixture of 1 part of creosote to 20 of petroleum jelly or sump oil will effect a cure. When, however, it is well established, dipping is recommended.

The dip is prepared by dissolving 2 oz. of soft soap and $\frac{3}{4}$ oz. of sodium fluoride per gal. of water and mixing into this 2 oz. of flowers of sulphur. Sufficient dip should be made up to cover the bird's back when standing in the bath. The dip should be comfortably warm.

When the bird is dipped the feathers should be ruffled in order to wet the skin, while the head and neck should be dipped two or three times or bathed with a wad of cotton-wool. After dipping, as much of the dip as possible should be squeezed from the feathers.

Dipping should be done on a warm, quiet day, and should cease sufficiently early in the afternoon to ensure that the birds are dry before going to perch.

Scaly Leg. This disease is caused by a mite that lives under the scales of the legs and feet, where it causes great irritation. This results in a multiplication of the tissue cells and the secretion of serum. The scales are raised, and the legs become thickened and have a rough, lumpy appearance.

The disease is easily recognized. It is contagious, but some birds appear to be immune. It is most common among flocks kept on earth or cinder runs.

In the early stages it seems to cause little inconvenience, but should it be neglected the birds lose condition, go lame and have difficulty in perching.

Treatment is simple. The affected parts should be dressed with equal parts of linseed oil and paraffin applied with a tooth or nail-brush. Sulphur or coal-tar ointment are also effective.

When paraffin is used care should be taken to prevent its coming in contact with the flesh above the hock-joint. This causes considerable shock. Careless handling of paraffin may even result in the death of the bird.

Fleas. The hen-flea will not be troublesome in houses that are kept clean, but it is often abundant in dirty houses.

The flea, in common with other external parasites, is more prevalent during the warmer months of the year. The eggs are laid among the dust and dirt that accumulate in the cracks and crevices of the house. The floors and nest-boxes are favourite breeding-grounds.

Should fleas become established, drastic measures must be adopted for their eradication. It is useless to apply "insect powder" to the nest-boxes and expect to get rid of the pests. They may be driven from the nests, but they will breed elsewhere.

Nests should be cleaned, disinfected and relittered. One of the newer insect powders to which reference has been made should be applied to the house and nest litter, the roosts and lower part of the walls being sprayed with insecticide. It is wise to repeat treatment about a week later.

During recent years a number of fumigants (often called "smoke generators") have been produced. They are very effective for the control of insect pests, and houses so treated retain their lethal qualities for some time.

When using these fumigants it is sufficient to close doors and windows of the house; it need not be hermetically sealed.

For spraying vacant houses during the annual "spring cleaning" one of the modern insecticides should be used. The application should be generous; the solution should penetrate all cracks and inaccessible spots.

Mites in Litter. Occasionally the litter in laying and broiler houses becomes heavily infested with mites, which will also be found on the birds and their attendants.

Investigation has shown that the mites are various species of meal or forage mites, and so far as is known they are innocuous. They frequently disappear without treatment. It is doubtful whether steps to eradicate them are justified, but should they cause the poultryman anxiety, a suitable insecticide should be dusted over the litter.

Deficiency Diseases. *Nutritional Roup.* Nutritional roup arises from a deficiency of vitamin A. The symptoms closely resemble those of the common cold and fowl pox.

The disease begins with a thin, watery discharge from the nostrils and eyes. The latter may swell, owing to the lids being gummed together by the dried mucus, and a whitish deposit covers the eyes. Cheesy, white pustules appear in the œsophagus. Affected birds show paleness of comb, etc., loss of flesh and debility.

Photo Modern Poultry Keeping

FIG 284—VITAMIN-A DEFICIENCY RESULTS IN SYMPTOMS RESEMBLING THE COMMON COLD

The swollen eye and inability to breathe through the nostrils are in this case due to Vitamin A deficiency

Post-mortem examination may reveal enlargement of the kidneys, which are streaked with white urates.

The disease is easily preventable. The inclusion of substances rich in vitamin A such as cod-liver oil, fresh green food, alfalfa meal, dried grass, etc., in the ration will ensure adequate protection against this disease.

A deficiency of this vitamin lowers the resistance of the birds to infectious diseases. Hence it is commonly called the protective

vitamin. Foods rich in vitamin A rapidly lose their efficiency by exposure to air. Cod liver oil should be stabilized.

Curled-toe Paralysis. Curled-toe paralysis in chicks is due to a deficiency of riboflavin (vitamin B2).

Symptoms in chicks are leg weakness, and when forced to walk they do so on their hocks, with their toes curled inwards under the foot, and enlarged nerves of the leg are seen in laboratory diagnosis. These symptoms usually become mani-

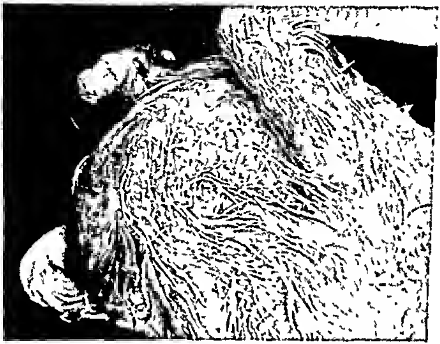

Photo J Getty

FIG 285—RIBOFLAVIN DEFICIENCY. "CLUBBED DOWN" IN A 21-DAY EMBRYO

fest from the second to the fourth week of a chick's life, although cases have been reported as early as the seventh day and as late as the fifty-sixth.

In adult birds lack of this vitamin is responsible for low hatchability, abnormal embryos, embryonic mortality and "clubbed down".

At one time "clubbed down" was regarded as diagnostic of riboflavin deficiency, but recent work suggests that the symptom does not necessarily indicate a deficiency of this vitamin. Possibly riboflavin and vitamin B12 are both necessary to prevent the condition.

Good sources or riboflavin are milk, yeast, alfalfa and grass. Milk in powder or liquid form and dried unextracted yeast should be regarded as valuable additions to the chick-mash, and it is also desirable to include a small percentage of these foods in the breeders' mash. Synthetic riboflavin is now obtainable at an economic price.

Dermatitis in Chicks. Pantothenic acid deficiency is responsible for retarded growth and poor feathering. The chicks become emaciated and develop crusty scabs in the corners of the mouth and on the eyelids. The skin of the feet and toes cracks and sores appear at these points. Few cases are reported in this country, because common chick-foods, such as yeast, milk, bran and alfalfa meal, are good sources of pantothenic acid.

Photo: Modern Poultry Keeping

FIG. 286.—A TYPICAL CASE OF RICKETS IN CHICKS

Rickets (Rachitis). This condition is characterized by incomplete calcification of the bones. It is most common in young chicks reared in total confinement, but may occur in adult birds, especially if they are closely confined.

Rickets is due to lack of mineral matter—calcium and/or phosphorus in the ration, or inability of the birds to assimilate it owing to their being deprived of direct light, or, in its absence, some potent source of vitamin D3, such as cod-liver oil or one of the synthetic forms.

In chicks the onset usually occurs during the third week. A tendency for the birds to sit about on their hocks is an early symptom. The shanks have a dried-up appearance, the feathers become ruffled and finally the birds suffer from "leg weakness".

There is a widespread belief that unless leg weakness occurs chicks are not affected with rickets This is not necessarily correct They may be affected in some degree and show curvature of the ribs, crooked breast-bones, poor feathering and slow growth, and yet not "go off their legs"

Rickets can be prevented by feeding a ration having a balanced mineral content and exposing the birds to direct light, or including vitamin D_3 in the diet

The calcium-phosphorus ratio varies in accordance with the nature of the diet, the amount of other minerals present and the conditions under which the chicks are kept Under favourable conditions the requirements will be met by the addition of 2 per cent of limestone flour or powdered oyster-shell, since the average ration contains sufficient phosphorus.

It should be mentioned that an excess of one mineral may affect the availability of another For example, the addition of a large quantity of calcium carbonate will reduce the amount of available phosphorus, similarly, an excess of phosphorus-rich substances will reduce the amount of available calcium

The point is of practical importance because in ordinary circumstances the addition of bone-meal to the mash when chicks show symptoms of rickets is likely to aggravate the trouble, because it is not usually due to a deficiency of phosphorus, and an excess of the latter will deprive the chicks of calcium

Rickets is essentially a nutritional disease It is not inherited, but undoubtedly there are certain individuals unable to assimilate mineral matter in a normal manner, hence the tendency to soft bone This tendency may be inherited

Crazy Chick Disease (*Encephalomalacia*) The cause of this disease is unknown For many years it was thought that vitamin E deficiency was responsible, but the condition may occur among stock having a diet containing an adequate amount of this vitamin Moreover, attempts to reproduce the condition by feeding vitamin-E-deficient diets have failed

It is attributed to the destruction of vitamin E by the inclusion of rancid oil or an excess of oil in the diet, while some workers consider that it arises from fatty acid toxicity.

The disease has been extensively studied. Singsen and his

co-workers (1955) found that the addition of fish oil to the diet induced mortality from encephalomalacia, but that it could he prevented by the addition of eleven I.U. vitamin E per lb. of ration.

They also found that mortality from this disease could be prevented by the addition of an anti-oxidant to the diet. It was concluded that the primary function of vitamin E in preventing the disease was that of a general biological anti-oxidant.

Some workers have suggested that the disease occurs in chicks from breeding stock having a diet deficient in vitamin E.

Crazy chick disease is frequently associated with coccidiosis. Affected chicks are droopy, and stand about with their eyes closed for long periods. Later there is lack of co-ordination of the muscles, the head may be twisted or drawn close to the body, the bird walks with difficulty, and finally becomes completely prostrate before death.

These symptoms usually occur in chicks from fourteen to thirty days old, although the disease has been known to occur as early as the seventh day and as late as the fifty-sixth.

Since the symptoms cannot be distinguished from those of fowl pest and epidemic tremor, expert advice should be sought.

Perosis (Slipped Tendon). In perosis the bones are usually well calcified, but bowing or twisting of the leg-bones occurs, and the tendon slips out of the groove in the hock-joint.

The condition is not due to rickets. It is associated with mineral imbalance, such as a deficiency of manganese or excess of phosphorus, or a deficiency of certain "B" vitamins.

Slipped tendon frequently occurs when chicks are given mashes containing a high percentage of maize meal and concentrates rich in phosphorus—*e.g.*, fish meal and bone meal. Odd cases may occur from time to time. They can be attributed to a constitutional defect, and should not be regarded as evidence of nutritional deficiency. Only when a number of birds are affected should changes be made in the composition of the diet.

Constitutional Diseases. *Abdominal Dropsy (Ascites)* is common in fowls, especially hens. There is no specific cause of the condition, which may arise from a mild case of peri-

tonitis of long standing, interference with the venous circulation by a tumour or other obstruction, or may be associated with diseases of the liver, kidneys or heart.

The condition is easily recognized. The abdomen is distended, and when handled feels full of water, as in fact it is. There is no cure.

Bronchitis, or inflammation of the bronchial tubes, is caused by draughts, dampness, sudden changes in the weather and exposure to cold, wet conditions. It may also be caused by excessively dusty litter or food.

The condition is a fairly common one, odd birds being affected from time to time. The most characteristic symptom is a bubbling or rattling sound in the windpipe and bronchi, due to air passing through the mucus that accumulates in the affected parts.

Breathing is difficult, the bird opening its mouth and gasping. The bird coughs and becomes distressed. If the disease develops, there is increasing weakness, the bird being unable to stand.

Symptoms are similar to those in more serious respiratory diseases, and if several cases occur it is advisable to send specimens to the laboratories.

Round Heart Disease. Abnormal conditions of the heart have been observed in poultry for many years, but in the early 1940s a number of cases occurred in which the heart was rounded and enlarged. Since that time many outbreaks of so-called round heart disease have been reported mainly in deep-litter units.

The cause of the disease is not understood. Usually young birds are affected, the greatest mortality being among stock from five to eight months old, but losses may occur earlier or later.

Affected birds are usually in good condition. As a rule death takes place suddenly, frequently at feeding time or when the birds are being handled, or suddenly disturbed. Symptoms are, sudden collapse, the birds falling over, flapping the wings and paddling the legs.

Post-mortem examination shows a rounded heart which is enlarged, in some cases being more than twice the normal size, with a " dimple " at the base.

Evidence suggests that the heart condition is present for some time before death, the excitement or crowding at feeding time causing stress which the heart is unable to withstand.

Bleeding Cysts occur in certain birds. External cysts first appear as small swellings, which later break and bleed profusely. Eventually bleeding ceases, only to recur at intervals.

Bleeding cysts are a type of tumour known technically as angioma. They may bear some relationship to the leucosis complex. They can occur in or on any part of the body. They are thought to be inherited, and therefore affected birds should not be used for breeding purposes.

Photo: Modern Poultry Keeping

FIG. 287.—BUMBLEFOOT

The cysts may be removed surgically. Some poultry-men recommend forcing a sharpened crystal of copper sulpbate into the cyst, others advise applying a caustic pencil inside the cyst.

If treatment is successful the birds should be marked to avoid their inclusion in the breeding-pen.

The condition is comparatively prevalent in some strains, and the writer has seen flocks of first crosses in which cases have been relatively numerous.

The cysts are not in any way associated with hæmophilia, a disease responsible for slow clotting of the blood. They are tumour formations of the walls of the small blood-vessels.

Bumblefoot. This is a swollen condition of the foot due to a wound becoming septic or to bruising of the foot as a result of the birds jumping from high perches to hard floors.

It may arise from the birds stepping on thorns, wire, nails and other sharp objects, and from the use of unsuitable litter. Thistles among the litter may cause the trouble.

Affected birds are seen to limp, and examination shows the foot to be more or less swollen. The foot should be washed with warm water containing a mild disinfectant, and when quite clean the swelling should be lanced with a sterilized sharp knife. This operation should not be carried out until the swelling is quite hard or " ripe ".

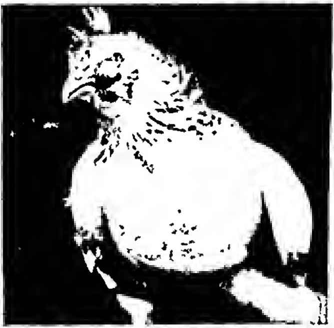

Photo: Modern Poultry Keeping

FIG. 283.—A " FIGHTING BUMP "

The swelling at the base of the beak is due to the accumulation of pus following a small wound

It is essential to make a fairly deep cut and dig out the core of the swelling. The wound should then be swabbed with a disinfectant solution, dressed with tincture of iodine, bandaged with a clean rag, and the bird placed in a clean, well-littered coop. It may be necessary to repeat the operation.

Treatment is not by any means invariably successful, but is worth while attempting if the bird is considered of sufficient value to justify the time and trouble. In some instances infection extends up the leg and involves the body.

Canker is an ulceration of the mouth, and usually occurs at the junction of the upper and lower beak.

The condition is often described as a "fighting bump" because it may follow wounds caused by fighting, although it very frequently arises from a slight injury to the tissues by a sharp object. This results in the accumulation of pus.

When the swelling is "ripe," the contents should be squeezed out or removed with a probe, care being taken not to cause bleeding. Cleaning of the area and an application of tincture of iodine solution should follow.

This condition is prevalent during the late spring and summer months. It may be associated with loss of vitality at this season.

Clogging of the Beak: Food-clogging in the beak is occasionally reported. Masses of food accumulate in the tip and base of the beak and under the tongue, resulting in necrosis—death of the tissues. The trouble usually occurs among chicks. It may arise from the feeding of finely ground cereals—in other words, from feeding a mash of too fine a texture.

It may also occur where a normal ration is being fed if the birds breathe through the mouth as a result of respiratory or other diseases. Mouth-breathing is commonly responsible.

The clogged food may be removed with a small probe, such as a sharpened match-stick. Obviously the cause should be ascertained and removed.

Congestion of the Lungs (Chilling) occurs in all classes of poultry, but is especially prevalent among young chicks.

Many thousands of chicks die as a result of this condition every season. A great number of laboratory reports of post-mortem examinations of chicks refer to it or to inflammation of the lungs, which is a stage beyond congestion.

It is caused by chilling and exposure, the contraction of blood-vessels of the surface of the body forcing the blood to the internal organs. It may also be due to keeping newly hatched chicks in the incubator without sufficient ventilation, to chill in transit, a fluctuating temperature in the brooder, or over-heating or overcrowding with some chicks pushed to the outside.

There is no satisfactory treatment. It is a matter of prevention.

Convulsions. From time to time reports are received of chicks showing symptoms of fits. They fall on their sides, kick vigorously, flap the wings and twist the head. They rapidly recover and behave normally, only to suffer subsequent attacks.

It is possible that convulsions may arise from the chicks becoming debilitated, perhaps on account of faulty brooding conditions. It is doubtful if convulsions can occur as a distinct disease entity, and in most instances are probably a symptom of some infection or disorder of the nervous system, for example, Newcastle disease, epidemic tremor, crazy chick disease and salmonellosis, which can only be differentiated by laboratory techniques.

In view of the fact that nervous symptoms occur in fowl pest, it is recommended that all such cases should be reported if the incidence of nervous symptoms is high or appears to be spreading.

Dizziness, staggering and peculiar head movements in adult birds are usually associated with worm infestation, toxins and direct brain trouble, or long exposure to blazing sunshine.

Crop-binding, Sour-crop. Crop-binding and sour-crop are symptoms of indigestion. The former is caused by the birds swallowing material that blocks the outlet from the crop. It is frequently due to the consumption of long grass, feathers and litter, but may arise from debility. It may be of two types, mechanical or constitutional.

The former may arise from consumption of long grass, etc., owing to lack of roughage in the ration, or it may be associated with worm infestation, or to irritation or inflammation of the digestive tract. It is quite evident that the presence of long grass or unsuitable litter is not the primary cause, because healthy birds receiving a normal ration will not eat these things.

In the constitutional type it may be a symptom of fowl paralysis, when the nerves of the digestive tract are involved. It is also frequently seen as a symptom of " pullet disease ". If, therefore, many birds are affected, an effort should be made to find the cause and remove it.

Symptoms are characteristic. The crop is greatly enlarged and doughy to the touch. The bird mopes and makes convulsive movements with its neck in its efforts to force the

contents out of the crop. There is absence of appetite and rapid loss of condition.

Relief may be given by pouring a teaspoonful of olive oil down the œsophagus and massaging the crop with the fingers, breaking up the mass. The bird should then be placed in a coop, when the material may pass out of the crop.

Should this treatment fail, it will be necessary to operate. The operation is quite a simple one, and may be described as follows: Pluck a few feathers from the area of the crop, wipe with a cloth dipped in disinfectant, and then with a clean, sharp knife make an incision about 1½ in. long. Remove contents of crop with a spoon (or button-hook if long grass is present), and swab the crop with a mild disinfectant such as permanganate of potash. Then stitch the wound by sewing with needle and thread, the stitches being about ½ in. apart. It is unnecessary to make separate stitches, but the last one should be finished by tying the ends of the thread. Sew the crop-wall and the skin over it separately. Finally dress the wound with an antiseptic ointment.

The bird should be given a light diet of bread and milk for a few days after the operation.

Sour-crop may be due to feeding musty or putrid material, irregular feeding, the consumption of irritating chemicals, inflammation of the crop lining, debility and other factors.

The extent to which general debility may be responsible is well illustrated in the following example. A poultry-man reported numerous cases of sour-crop among a flock of pullets kept in total confinement. The usual treatment was adopted with limited success. Cases continued to occur.

Investigation showed that although the birds had an abundance of floor-space, there was insufficient ventilation when the windows and shutters were closed at night.

Compelled to spend many hours in a stuffy atmosphere, the birds became debilitated, were unable to digest their food in a normal manner, and as a consequence developed crop trouble.

Sour-crop should be treated by holding the bird head downwards, gently squeezing the crop, forcing out the contents through the mouth. Then give the bird tepid water and repeat the procedure. Having emptied the crop, give milk to drink or

water containing a little bicarbonate of soda. Withhold solid food for a day.

Diarrhœa is a symptom of many diseases of poultry, but it must not be supposed that its appearance is necessarily due to contagious or infectious disease.

Diarrhœa is common among fowls. In some birds a mild diarrhœa seems to be chronic. In all other respects they are normal.

What may be termed simple diarrhœa may arise from a great variety of causes—for example, sudden change of feeding, improper feeding, exposure to cold, wet conditions, and general debility as a result of such environmental factors as confinement to stuffy or draughty houses. Too much up-draught in slatted-floor houses is a prevalent cause of abdominal chills, which in turn cause diarrhœa. Temporary looseness of the bowels of individual birds, provided they show no other symptoms of ill-health, is without significance.

Should the condition be widespread, the cause should be found and removed. Feeding is most commonly responsible.

For flock treatment a dose of Epsom salts (2 oz. per gallon of drinking-water) should be given. The addition of 1 to 2 per cent of vegetable charcoal in the mash for a few days is advised.

Liver Degeneration. The term "liver disease" is commonly used by poultry-men. It includes a variety of conditions arising from many different causes. For this reason it is confusing, and is in fact a term that should not be employed.

Some diseases of the liver are due to specific disease—*e.g.*, tuberculosis, lymphomatosis—some are constitutional, others are due to errors in feeding, while some are secondary to other diseases. The commonest condition is fatty degeneration and rupture with hæmorrhage.

As far as feeding is concerned, it may be said that this is not responsible, provided the ration is well balanced. If, however, an excess of any one foodstuff is fed, then necessarily it throws a strain on the liver and other organs, which may break down. Thus liver troubles are often attributed to feeding and excess of starchy foods.

There is no treatment for the various liver diseases.

Nephritis. Nephritis is inflammation of the kidneys. It is frequently found in poultry. It may be caused by visceral gout, pullet disease and feeding errors (vitamin A deficiency), while long exposure to cold wind and rain, especially when the birds, wet to the skin, go to perch, are predisposing factors.

Growing stock reared on exposed range with inadequate shelter are frequently affected, although the symptoms may not appear until the birds are mature. Appetites are poor, there is progressive loss of weight, diarrhœa and in some cases lack of co-ordination of movement.

It is popularly supposed that high-protein feeding will cause this condition, but there is no evidence to support this supposition.

Dropped Abdomen. Dropped abdomen is caused by relaxed muscles failing to support the part. Heavy layers and older birds in an over-fat condition are usually affected. It may also occur as a symptom of peritonitis and ascites.

With the dropping of the abdomen the bird assumes the almost vertical attitude of a Runner duck.

There is no treatment for the condition. Affected birds will continue to lay but their eggs will not be fertile.

Emphysema. Subcutaneous emphysema is an abnormal amount of air under the skin. It may give young chicks the appearance of being blown up like balloons.

It is usually associated with respiratory troubles. Rupture of the air sacs, the trachea or other organs containing air is responsible. It frequently follows surgical caponising.

Pricking the skin will enable the air to escape.

Layer's Cramp. A condition known as layer's cramp occurs in individual birds, usually shortly after they have commenced to lay.

Affected birds squat on their hocks. They are unable to stand, but in all other respects appear to be healthy. The combs are full and red, the eyes bright.

Layer's cramp is usually the result of depletion of mineral matter due to exceptionally high egg production. This causes softening of the bones—osteoporosis. The condition may also arise from a deficiency of mineral matter (or mineral imbalance).

Layer's cramp occurs in odd birds having well-balanced diets.

In these circumstances it may be attributed to a constitutional defect—the birds being unable fully to assimilate mineral matter

Some cases are due to the presence of an abnormally large egg in the oviduct

Prompt treatment of the case is usually successful The bird should be placed in a well-littered coop or hamper, given a dose of Epsom salts—about ¼ teaspoonful in a dessertspoonful of water—and a light diet of bran or oats for a few days

Limberneck Limberneck is characterized by paralysis of the muscles of the neck, the neck hanging loosely on the ground The bird is incapable of raising it, or may partially do so by great effort Another feature of the disease is that if the feathers are lightly pulled they readily come out Limberneck may be due to botulism, but as far as the writer is aware this has not been reported in Great Britain The botulism germ produces toxins in putrid meat and decaying vegetable matter, and when these toxins are absorbed by the blood they cause paralysis of the nerve centres

Parts of the body other than the neck may be affected

If taken in time, ½ teaspoonful of Epsom salts in a dessert spoonful of water, repeated if necessary, may effect a cure The bird should be isolated in a cool, quiet place

As a precautionary measure the remainder of the flock from which the affected bird was removed should be given Epsom salts—1 lb per 100 birds

The run should be examined Dead rats, rabbits or birds may be the cause of the trouble

Cases resembling limberneck have been observed in which, if the birds are placed in a cool, dark coop they recover without treatment

Wryneck Wryneck differs from limberneck in that the neck is held taut and bent over the body The condition arises from direct brain trouble or nerve irritation Affected birds should be killed

Obstruction of the Oviduct (***Egg bound***) This trouble is most commonly caused by the presence of a large egg, which the bird is unable to pass It may also arise from twisting or other obstruction of the oviduct, from exhaustion or paralysis

Symptoms are diagnostic The bird frequently goes to the nest, where she strains to lay, but is unable to do so Later she

will be seen straining to lay on the floor of the house or in the run, and becomes very distressed

If the trouble is due to a large egg in the oviduct—and in the great majority of instances this is so—the egg may be felt as a hard mass if the obstruction is in the lower part of the oviduct If higher up it cannot be felt, but symptoms will indicate the nature of the complaint

The first step is to assist the bird to lay For this purpose steam the vent over a jug of boiling water, then lubricate the vent with olive oil and put the bird in a quiet coop She may lay within a couple of hours or so

Should this treatment be unsuccessful, wash the hands, smear the index-finger with antiseptic ointment, insert into the vent and with the palm of the other hand held against the bird's abdomen try to remove the egg Great care must be taken to avoid injury to the oviduct The finger-nail should be cut very short

If the egg cannot be removed in this manner it will be necessary to break the egg Proceed as follows Hold a small probe against the index-finger so that the latter protects the sharp point Smear the finger with antiseptic ointment and carefully insert into the vent Having located the egg, move the probe forward and break the shell When the shell is broken make quite certain that the whole of it is removed Tweezers should be at hand for the removal of small pieces of shell

Finally give the bird a teaspoonful of olive oil and a light diet for a few days

Œdema of the Wattles Œdema (swelling) of the wattles is seen occasionally As previously stated, it may be a symptom of the chronic type of fowl cholera Most commonly it is the result of an accumulation of pus following a small wound Cockerels, with their large wattles, are more liable to be affected than hens

Swollen wattles should be removed with a clean sharp knife or surgical scissors, the raw surface bathed with a mild disinfectant solution and finally dressed with friar's balsam, or a little cotton-wool should be applied to check bleeding.

Peritonitis. Peritonitis is inflammation of the peritoneum—the thin membranous lining of the abdominal cavity. The

condition is one of the commonest non specific conditions in poultry Laboratory reports frequently refer to it It may be acute or chronic

A number of conditions may set up peritonitis, the most prevalent being impaction and rupture of the oviduct It may also arise as a result of rupture of the digestive tract, ulceration due to coccidiosis or the presence of egg material in the abdominal cavity It is often a sequel to B W D degeneration of the ovary

Diagnosis during life is extremely difficult Usually diarrhoea is present in greater or lesser severity, and the abdomen may be pendulous

There is no effective treatment The house should be free from draughts, especially about the perches In slatted floor houses too much up draught should be avoided

Prolapsus (Eversion of the Oviduct) is not uncommon, especially in flocks of young pullets that are laying heavily

The condition is easily recognized a mass of reddish tissue protrudes from the vent, this tissue being the lower part of the oviduct and cloaca

Prolapsus may be due to a number of causes—*e g*, constipation, some obstruction in the oviduct, inflammation of the oviduct, or straining to pass a large egg—but the most common cause is failure of the muscles to support the parts under the strain of heavy production That is why the trouble is always more prevalent when pullets are coming into production and in the spring

Prolapsus is simply a physical breakdown It is not infectious or contagious, and is not therefore a serious condition in itself

Unfortunately, cases occur without warning and unless the bird is promptly removed from the flock, others will peck the part, when peritonitis usually sets in with fatal results Moreover, even a simple case may cause an epidemic of vent pecking

The affected bird should be immediately removed from the flock Treatment is simple, but not always successful Wash the exposed parts with warm disinfectant solution, and when perfectly clean smear the fingers with boracic or other suitable ointment and gently replace the parts Having put them

back, it is desirable to syringe the vent with cold water or strong cold tea to stimulate muscular reaction. Place the bird in an isolation pen, give a teaspoonful of olive oil and a very light diet for a few days, with the object of discouraging egg production. It may be necessary to repeat the treatment.

Vent Gleet is ulceration of the vent and lower bowel. There is a whitish discharge, which accumulates on the abdominal fluff. The vent and bowel show areas of ulceration and there is a characteristic stinking odour.

At one time it was thought to be a true venereal disease of poultry, but no specific organism has been isolated. It is probable that a number of organisms are responsible for the condition and that they probably enter the tissues through small wounds or sores.

The disease is usually confined to females. It is said to be infectious, but in the writer's experience infectivity is low.

Treatment is difficult and tedious. It is wiser to get rid of affected birds. If, however, a case is taken in its early stages and treatment is considered worth while, the matted feathers should be clipped away from the vent, and the area washed with warm disinfectant solution. A little iodoform ointment should be inserted into the vent, and finally the area should be dressed with iodoform powder. The treatment should be repeated twice daily until the condition clears up. In some cases penicillin ointment has proved successful.

Affected birds should be isolated at once. Attention should be paid to the disinfection of the nest-boxes, and new litter should be used.

Poisoning. Cases of poisoning in poultry are reported from time to time, frequently as a result of the birds obtaining access to rat poisons containing compounds of phosphorus and/or arsenic.

In the *Veterinary Record* (May, 1945), Blaxland and Gordon state that the four commonest causes of acute poisoning in poultry are phosphorus, arsenic, zinc phosphide and cacao-bean residues.

The greatest care should be taken when using rat poisons of the above types, which, even though placed out of reach of the birds, may be carried into the poultry run or house by the rats.

Certain rat poisons contain Salmonella organisms, which, while having no apparent effect on the birds, may cause them to react to the blood test for B.W.D.

Recently an effective and completely safe method of rat and mouse destruction has been found in Warfarin.

This preparation, which is given as a food-bait, when sufficiently concentrated in the blood produces internal hæmorrhage and prevents the blood clotting, with the result that vermin bleed to death. A short time is required to build up full effectiveness, that is to say, the compound is not immediately lethal.

Black nightshade, milkweed, lily of the valley and oleander have caused poisoning, but when a normal diet is fed birds rarely eat anything likely to be injurious. Instinct seems to tell them what is harmful.

The use of seed corn dressed with mercurial and organic sulphur compounds must be avoided.

When poultry are kept in orchards treated with washes, they should be removed from the orchards or confined to the houses pending heavy rain, sufficient to wash the compounds off the grass.

Grain infested with weevils may cause trouble. During the war a consignment was fed to a flock of pullets in lay. Severe diarrhœa followed, the birds moped, showed blueness of comb and there was a slump in egg production.

Moulds. Before the war it was customary to reject mouldy food. But the use of pudding during the war years showed that moulds are not necessarily injurious and, as recent work with antibiotics shows, they may be beneficial. It depends entirely on the type of mould. As a general rule, however, it is wise to avoid mouldy feeding-stuffs.

Salt Poisoning. While common salt is beneficial to poultry if given in small quantities, an excess is injurious, and may have fatal results, particularly with chicks.

Gallagher reported that 2½ drams of this salt is a toxic dose for chickens. Later investigation has shown that by gradually increasing the percentage of salt in the ration a very high proportion may be fed without causing death.

For practical purposes, however, not more than 1 per cent should be fed in the ordinary course of routine.

Potato Poisoning Green potatoes and potato shoots contain considerable amounts of the alkaloid solanin This is highly toxic.

In the writer's experience mortality due to this cause is rare in this country, but there seems little doubt that the poison may be responsible for cases of diarrhœa that are reported in the spring and summer months Sprouting tubers should have the shoots removed, and green tubers should not be fed to poultry

Corn-cockle Poisoning The seeds of corn-cockle are highly poisonous Fortunately, they are so unpalatable that they are usually avoided by birds, but when the seeds are ground up with corn they may occasionally be eaten in sufficient quantity to be fatal

Unclassified Diseases. *Pullet Disease* A case of "pullet disease" was first reported in this country in 1943 No further instances were reported until July of the following year Since that time numerous outbreaks have occurred on farms in all parts of the country. The mortality rate is low, varying from 2 to 25 per cent of the flock, although up to 90 per cent of the flock may be affected.

Usually the first symptom is a severe drop in egg production, followed by diarrhœa varying in colour from green to white The birds are dull and have ruffled plumage As a rule the crop is distended and full of sour-smelling, doughy foodstuffs A characteristic symptom in individual birds is a blue comb and loss of condition

In fatal cases death usually occurs four to seven days after the onset of symptoms

After ten to fourteen days egg production gradually increases as the birds recover condition

When the disease first appeared many suspected the food, but this has not been confirmed by experimental work

Since outbreaks usually occur in late summer and autumn, the disease has been called "New Wheat disease" There is no evidence, however, that new wheat is responsible

Recent work shows that treatment with antibiotics is more effective than measures formerly recommended

Affected flocks should be given terramycin or aureomycin at the rate of 50–100 grams per ton of feed for seven to ten days,

followed by feeding antibiotics at half this level for a similar period At the same time ½ pint molasses should be added to each gallon of drinking water

Fatal cases of this disease show changes in the kidneys, which may be enlarged and present a streaky appearance with deposits of urates, a condition known as visceral gout (uric *nephritis*) The liver may be spotted and other organs may be congested

Although pullet disease usually occurs among young birds in lay, immature pullets may be affected, as also may cockerels

Six day Chick Disease Reference to "six day chick disease" will be found on p 425

Hæmorrhagic Disease This disease may be a major source of loss among chicks, notably in broiler plants, where it may rank second only to coccidiosis in economic importance

The cause is unknown Although outbreaks are occasionally associated with the use of coccidiostats, particularly sulpha drugs, there appears to be no evidence that they are directly responsible Attempts to produce the condition by dosing, even excessive dosing, with these drugs have failed It would seem therefore that other factors are involved

A diet deficient in vitamin K is said to induce outbreaks, but according to Cover *et al* the disease is not associated with a deficiency of this vitamin

Other factors have been suggested and investigated by numerous workers, nevertheless, research has not so far revealed the precise cause of the condition

Outbreaks frequently occur among chicks and growing stock of any age The onset is sudden, mortality rising rapidly, perhaps up to 50 per cent in severe cases, and gradually subsiding in the course of about ten days

In many respects symptoms resemble those of coccidiosis Chicks huddle together, shiver, droop the wings and may pass blood in the droppings

Some birds have external hæmorrhages under the wings in the comb, legs and other parts

Post mortem examination shows many hæmorrhages in the intestines, muscles, heart, liver and spleen Nephritis is commonly seen

At present no specific treatment can be recommended In

some outbreaks the use of molasses and antibiotics as recommended for pullet disease have given favourable response.

In the event of an outbreak it would seem advisable to discontinue the use of coccidiostats, but this does not imply that they are responsible for the condition.

The fact that some outbreaks are associated with the drugs in no way detracts from their value in the prevention and treatment of coccidiosis. The drugs are now widely employed, but only in very few cases is their use followed by hæmorrhagic disease.

There is evidence that outbreaks may arise as a result of intercurrent disease or some stress factor.

Vices. *Toe-pecking.* Vices are not uncommon among poultry, and may cause serious losses unless immediate steps are taken to counter them.

Toe-pecking occurs among chicks, bleeding follows, and the victims go down like ninepins.

The trouble is more prevalent in bright, sunny weather when the chicks are reared on floors littered with peat moss or other dark material. The strong sunlight shines on the toes against the dark background. This attracts the chicks, and pecking begins.

The remedy is to replace the litter with cut straw to a depth of 3 or 4 in. The chicks' feet sink into this. Thus the vice is checked. Damaged toes should be dressed with Stockholm tar.

In the event of an epidemic it is advisable to cover the windows with red tissue paper or apply a red wash to them.

Feather-plucking and Cannibalism. These two vices may be considered together, for they are in the main due to the same factors. Feather-plucking, if neglected, may be followed by cannibalism proper.

When birds are kept closely confined, and particularly if they are compelled to stand about for some hours with nothing to do, there is a tendency for them to peck each other.

Perhaps a mark on the plumage will prove sufficiently attractive. A bird pecks the spot, draws the feather, and so the habit of feather-plucking is acquired; and once acquired it is not easy to break. Moreover, others in the flock follow the bad example. Consequently the birds soon have a very ragged appearance, with extensive bare areas.

Should blood be drawn—and it almost certainly will be sooner or later—cannibalism will follow. Cannibalism may also begin with a case of prolapsus, or the accidental drawing of blood, or it may arise from crowding in nest-boxes and at the food-troughs.

It seems that birds are quite unable to resist blood. A speck on the feathers or a little from a scratch on the comb will be the signal for them to start pecking, and then some form of cannibalism is imminent.

Photo Modern Poultry Keeping

FIG. 289.—AN ALUMINIUM PICK-GUARD OR VISOR FOR THE PREVENTION OF FEATHER-PLUCKING AND CANNIBALISM

It is frequently said that these vices arise from nutritional deficiency, that the birds peck each other because something is missing from the ration.

It is true that an unbalanced ration, particularly one containing an exceptionally high percentage of maize meal, may induce feather-plucking and cannibalism, but by far the great majority of instances arise from keeping the birds in idleness, overcrowding and lack of sufficient feeding-space.

Poor feathering undoubtedly accounts for many epidemics.

This, of course, may be inherited or nutritional, more commonly it is environmental Keeping the birds in a warm stuffy atmosphere or in overheated rooms, however well ventilated, will cause poor feathering

But the breeder should consider rate of feathering when

Photo Dewdrop Products Ormskirk Lancs

FIG 290 —PLASTIC "SPECTACLES" ATTACHED TO A BIRD'S BEAK TO PREVENT FEATHER-PLUCKING AND CANNIBALISM

selecting his stock Rapid feathering strains are less prone to cannibalism than those which are slow feathering

While it is doubtful whether these vices are inherited, it cannot be denied that birds differ markedly in their temperament Some are docile and will quickly settle down as a flock, others have an aggressive, quarrelsome temperament and constantly bully their associates It is among the latter that outbreaks of cannibalism are most frequent

It is possible to reduce the incidence of cannibalism by

selection Birds that are the trouble makers should not be used for breeding purposes

In these days of intensivism, ability to live peacefully in a flock is a very desirable character, it is also one of economic importance, since losses from vices can be severe

Richter (1954) concluded "with a certain degree of assurance" that feather eating was primarily connected with hereditary characteristics, that it should be regarded essentially as a hereditary fault He considered that it was a matter of conjecture how far environmental factors exerted their influence, but both genetic and environmental factors must be present for feather plucking to manifest itself

Although vices usually occur among closely confined stock, birds on extensive range are not immune from them This may be due to keeping them in the houses for several hours in the summer months before the attendant goes on his rounds to accidental drawing of blood or prolapsus Instances of feather-plucking among poorly feathered young stock are not infrequent, particularly among growing cockerels

Whether the birds are kept in confinement or on range, however, some individuals become "killers", or conversely some birds are weaklings that others bully

Whenever these troubles arise every effort must be made to deal with them at once Close observation may reveal the ringleaders If they can be identified they should be removed from the flock and housed in single bird cages Should this be impracticable, debeaking or fitting peck guards or hen spectacles is advised

Debeaking is now commonly practised

In the early stages paring the tip of the top beak to prevent the birds obtaining a grip on the feathers is often successful It may be necessary to trim only the horny tip of the beak Should the trouble be widespread, the upper beak should be cut well back, about one third being removed This will cause bleeding, therefore the raw surface should be seared by touching with a hot iron

When large flocks require treatment it is advisable to use one of the electric debeaking machines which remove part of the beak and at the same time sear the exposed surface Some poultry men also remove the sharp point of the lower beak

Debeaking may be undertaken at any age—at day-old if desired—but on the majority of farms the work is done when the pullets are placed in the laying houses Many debeak the birds only when feather-plucking or cannibalism occurs

Photo Vissi Chick Brooder Co Ltd, Colne Lancs

FIG. 291(a)—A DEBEAKING MACHINE

Photo Cope & Cope Ltd Reading

FIG 291(b)—ABOUT ONE THIRD OF THE TOP BEAK IS REMOVED

The cutting knife for the removal of part of the beak is operated by a foot pedal The raw surface of the beak is seared with an electrically heated plate

Dressing the parts most commonly attacked with an infusion of quassia chips is a deterrent. This makes the feathers unpalatable Quassia chips should be steeped in hot water over-night, and then the liquid should be poured off, and when cool applied with a brush to the feathers, or the flock may be treated by spraying the solution over the birds Proprietary compounds are now available for mass treatment

If the flock is a small one bare patches should be dressed with

Stockholm tar or the following ointment: 1 oz. lard or other grease, ½ oz. bitter aloes, ¼ oz. carmine.

This will deter pecking, but clearly the method is impracticable for large flocks.

Too much light in the house encourages vices. Reduction of window area and/or the use of red light may be the best

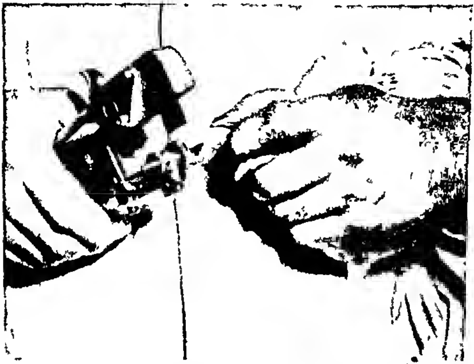

Photo: Cope & Cope Ltd., Reading

FIG. 292.—DEBEAKING A CHICK WITH A HAND MACHINE

solution of the problem; it is one frequently adopted in large-scale production.

Every effort should be made to keep the birds occupied. For this reason it is advisable to supply fresh green food, which should be placed in racks or suspended about 12 in. from the floor. Cabbage, kale, etc., are excellent for this purpose, as also are freshly cut lawn mowings—the latter being fed in troughs.

Straw should be used for litter, and a little grain thrown into it two or three times daily—not sufficient for a full meal, but enough to find work for idle beaks. Should the ration not contain common salt, it should be added at the rate of 1

per cent. If preferred, common salt may be dissolved in the drinking-water—1 oz. per gal.

In some outbreaks glutting the birds with raw meat (lights) has proved effective. Presumably the birds get so tired of blood and meat that they lose all desire for feathers. It has been found that the feeding of soaked grain tends to prevent feather-plucking, and a similar effect has been observed when oats are included in a high-maize ration.

The provision of neat fish meal in a separate trough has proved helpful in some outbreaks. Fish meal is a rich source of the amino-acid methionine. Neal (1956) presented evidence which indicated that methionine supplementation at a sufficient level can suppress cannibalism. This could be effective, however, only when methionine is fed at sub-optimal level. The average diet is not deficient in this amino-acid; nevertheless, the feeding of fish meal may be of value as a diversion.

Depraved Appetites. Depraved appetites may occur among poultry, the birds consuming litter, excessive quantities of flint grit, feathers and even their own droppings.

The cause may be nutritional. For example, litter may be consumed in an attempt to provide bulk in the diet; an excessive consumption of flint grit may indicate lack of calcium or other mineral imbalance or inability of the birds to absorb mineral matter due to adverse environmental conditions.

Worm infestation and diseases of the digestive tract are also responsible.

Egg-eating. Egg-eating, like feather-plucking, is simply a bad habit. One or two birds are ring-leaders. They break the eggs and proceed to eat them; then other birds join in the feast.

Trouble frequently begins when the birds accidentally break an egg—possibly a thin-shelled one—either in the nest or on the floor.

The taste for eggs is readily acquired, and soon becomes a craving, the culprits standing about the nest-boxes waiting for birds to lay.

Filling eggs with mustard, ammonia, asafœtida and other unpalatable substances is often recommended as a deterrent. It is of little value.

If the flock is kept under close observation, it is usually

possible to discover the offenders. They should be isolated or sold. If this course is taken at once, it is probable that no further losses will occur.

When, however, several birds have acquired the bad habit, debeaking is advised.

The nest-boxes should be raised at least 18 in. from the floor, and should not face the light.

China eggs should be used in the nest-boxes, and a few *should also be placed on the floor. Eggs should be collected* as frequently as possible.

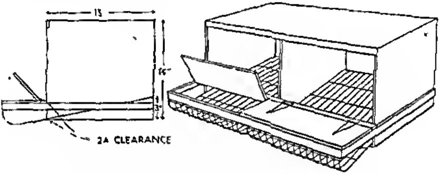

FIG. 293.—A NEST BOX TO PREVENT EGG EATING
Battery-cage floors may be used or 1 in mesh 16-gauge wire netting suitably supported.

As a further precaution, the upper part of the nest-fronts should be covered with hessian cloth, so as to darken them. Incidentally, this is also useful as a means of preventing vent-pecking, which may start in the nest-boxes. An ample number of nests should be provided.

Roll-away Nests. The use of nests of the roll-away type is the most effective method of prevention. It will also assist in keeping the eggs clean.

Roll-away nests are being employed on an increasing scale in deep-litter houses; when large flocks are kept intensively on wire floors they are essential.

Nests of conventional construction can be fitted with a false floor of 1-in. mesh 16-gauge wire netting (or 1-in. × ½-in. mesh welded wire), the netting being loosely fitted to light framing to provide a concave floor. A hole is cut in the centre of the netting for the egg to pass through to the nest floor proper.

The false floor may be covered with sheet rubber or suitable

plastic material. The nest floor proper should also be covered with soft material to prevent eggs being broken.

A better plan is to fit a sloping wire floor under the false floor, the former falling gradually towards the front of the nest. This under floor may be constructed in the form of a drawer which can be pulled partially out for egg collection. Curtains should be fitted to the nest fronts.

A more popular type of roll-away nest is constructed on the principle of the laying battery.

Floors may be of galvanized steel wire or plastic-covered copper wire, or they may be of wood or hardboard, covered with suitable sheeting or even carpet.

Floors may slope to the front of the nest, where eggs should be protected by a hinged board. In houses with service passages the nest floors should slope to the back, the eggs being collected from the passages.

Nests of this type should also have curtains fitted to the front.

Construction of these nests differs in detail. Some have floors of sheet rubber over plywood, other may be covered with carpet material, or the floor may be of straw or woodwool between two layers of small-mesh wire netting.

These so-called roll-away nest floors should be comfortable, or there may be difficulty in inducing the birds to use them, especially in deep-litter houses, where they may find the floor more attractive than the nests.

Sanitation. Sanitation is an important factor in the maintenance of health. It is a broad term, for it includes the conditions under which the birds are kept. These embrace housing, brooding and feeding equipment and, where extensive methods are practised, the land.

Dealing with the last-named first, it should be emphasized that poultry-runs, however extensive, should not be permanently occupied by the birds. The land should be given an adequate rest from feathered stock from time to time. On farms where the semi-intensive system is adopted every house should have alternate runs, and if possible these should be cropped or grazed by other stock when not occupied by poultry. Cropping is by far the best means of keeping the ground clean, but on the smaller farms this is not always practicable.

Grass Mixtures. Should the grass become unduly worn, and most certainly if the land is fowl sick, it should be ploughed and re-seeded with a suitable " seeds " mixture.

What constitutes a suitable mixture depends on the type of soil and the situation of the farm. This is a matter for the expert, and poultry-men should seek the advice of the County Agricultural Advisory Officers.

It is unwise to use a mixture recommended by a friend, or even one published in a technical article, unless the purpose, type of soil and general conditions for which it is recommended are known and are substantially similar to those existing on the poultry-farm.

A " seeds " mixture giving perfectly satisfactory results under a given set of conditions may fail under different conditions. For this reason an expert with local knowledge of soil and climate should be consulted.

Grass seed should be purchased from reputable firms. Only seed of the very best quality should be bought. It is unfortunate that many mixtures containing cheap and totally unsuitable seeds continue to find a ready sale among people who have no knowledge of grasses, of which there are many species differing in their habit of growth, soil requirements and nutritional value.

Grass of high nutritional value is of great benefit to the poultry-farmer, as it is to the general farmer. Far more attention should be paid to it; it should not be looked upon merely as a carpet to cover the soil. It plays an important part in the nutrition and maintenance of the health of poultry.

Poultry manure is rich in nitrogen, deficient in phosphate and potash. It is therefore an unbalanced fertilizer.

In view of this it is advisable to give poultry land an occasional dressing of phosphatic and potasic manures in order to restore the soil's balance.

The Value of Lime. Poultry-runs tend to become sour by reason of the accumulated droppings. To counter this it is customary to apply lime. Lime, being strongly alkaline, is of some value as a disinfectant, but it should not be regarded as a soil sterilizer, and too much faith should not be placed in it in this respect. It is helpful in preventing the land becoming " fowl sick ", but it is not in itself sufficient for this purpose.

The poultry-man should allow Nature's agents, the sun, wind, rain and frost, and especially the absence of the hosts—that is to say, the birds—to keep the ground in good condition and free from poultry diseases.

In normal circumstances lime should be applied at the rate of one ton per acre, two tons if the land has been heavily stocked or carried birds affected with infectious or contagious diseases.

Drainage. All poultry-land should be well drained. This is essential, because organisms responsible for the majority of poultry diseases thrive in damp surroundings. This applies particularly to coccidia, parasitic worms and the intermediate hosts of tapeworms.

Ditches should be cleared every year, and should water tend to lie on the ground, ditches should be cut along the side of the runs. Ditches in the runs are a nuisance.

Where necessary, pipe-draining should be undertaken. This work is expensive, but in certain circumstances it is the only solution of the problem.

Gravel or ashes should be used for muddy patches likely to develop in gateways and around the houses.

Mud is most undesirable on the poultry-farm. Every practical step should be taken to deal with it. It is bad for the birds as well as their attendants, resulting in loss of time and temper.

Holes made in the runs by the birds dust-bathing should be filled with soil and re-turfed or re-seeded when the runs are vacated. These holes not only make the runs unsightly, but water may collect in them. If it does, the birds will drink it. Surface drainage from the runs is a common method by which disease is spread from pen to pen.

Poultry-houses other than those of the small portable type should be fitted with guttering, with down-pipes to water butts and a soak-away to carry off the overflow. This will do much to prevent the ground becoming waterlogged, and will save labour in watering the stock. On some farms where the houses are fitted with large storage tanks water-carting is rarely necessary.

Cleaning Poultry-houses. At least once every year poultry-houses should be thoroughly cleaned and disinfected.

The first step is to get the house really clean. The litter should be removed or if in good condition it can be heaped as recommended in Chapter Three. All loose fittings should be taken out of the house, cleaned by brushing and scraping and finally sprayed with a disinfectant solution.

Perches, slatted floors and droppings boards should be soaked in water to soften encrusted material. This will ease the work of cleaning.

Roof, walls and floor should be cleaned with a vacuum cleaner or brushed with a stiff broom with short bristles.

If the litter has been removed the interior should then be washed with water, preferably under pressure. This will wash away a considerable amount of dirt, even from an apparently clean house.

Leave doors and windows open until the house is thoroughly dry, then spray with hot water containing 4 per cent washing soda (a 4 per cent solution is approximately 2 heaped handfuls of soda in 2 gal of water).

When the house is dry it should be sprayed with an approved disinfectant at the recommended strength.

Water cannot be used copiously if the litter is left in the house, but spraying first with washing-soda solution and later with a disinfectant solution should be carried out as a matter of course.

Aerosol dispensers will be found very effective; they are especially useful when the litter is not removed and in dealing with farm buildings. They may be the only practical means of disinfecting the latter.

Similar methods of cleaning and disinfection should be applied in the battery house. Cage floors and other fittings should be removed, soaked, brushed (or hosed) and disinfected, or the battery can be cleaned in the house with a steam jenny.

Care must be taken to prevent water getting into electric switches and fittings. As a precautionary measure against possible shock, current should be switched off during wet-cleaning operations.

Perches, slatted roosts and floors should be creosoted or dressed with paraffin and left in the open for a few days.

The need for thorough cleaning prior to disinfection must be emphasized. Wet cleaning is preferable to dry. It will wash

away the dirt and with it infection; it will prevent possible spread of disease by dust. In fact, if wet cleaning is really well done there is little need for disinfectants.

The effectiveness of disinfectants is much impaired if they are applied in dirty houses, indeed in certain circumstances it may be nullified.

Finally, all houses should be thrown open to air. They should not be re-stocked until thoroughly dry.

Chapter Twenty-one

The Business Side

As already indicated, poultry-farming is essentially a business proposition, and its success depends on many factors.

It is impossible to determine profits by making mathematical calculations, however conservative these may be, yet every prospective poultry-farmer seeks information about the business side, and it is with the object of giving him some indication of the return that may be anticipated on a well-managed farm that the attempt is made to detail his capital expenditure and estimate possible profits.

At the time of writing it appears that the cost of houses and appliances is more stable than for many years, although, of course, future price movements cannot be anticipated.

In recent years the average cost of feeding-stuffs has remained fairly constant, but the efficiency of the diet has been improved, hence on balance the poultryman is better off in this respect than he was a comparatively short time ago.

Wages, however, have risen, and seem likely to go higher, while the average price of eggs and table poultry has declined.

But commercial strains of both the egg and table poultry breeds have been improved and continue to be improved, as have management practices. As a result, average egg production is far higher, and table birds are reaching market weight in much shorter time than formerly.

Modern poultry are now mainly of two distinct classes—egg strains and meat strains. The so-called dual-purpose breed is losing its appeal for the reason that birds bred for a specific purpose are more profitable than those of strains selected for both egg and meat production qualities.

Both egg and meat strains supplied to commercial producers are crosses; many are bred on hybrid principles.

The value of high food conversion efficiency is now widely

recognized. Some years ago the average commercial egg producer paid little attention to this factor; many had no idea of the quantity of food consumed per dozen eggs produced. To-day more and more egg producers are following the example of the broiler growers; they study food conversion efficiency.

The economic importance of this factor is shown in Table 47, which relates to the five highest and five lowest scoring pens of 40 pens entered in the 5th 500 Day Commercial (Random Sample) Test 1959–60.

TABLE 47

Food Consumption and Costs

Data 5th 500 Day Commercial (Random Sample) Test 1959–60

Placing based on net return	Net return (total return less food cost).	H/H average egg production	Food consumed per doz eggs (lb)	Food cost per doz eggs.
	£ s d			s d.
1	67 0 7½	292 76	4 89	1 5 56
2	58 8 0½	278 48	5 17	1 6 53
3	55 8 11½	256 56	5 40	1 7 35
4	53 16 1½	244 40	5 19	1 6 55
5	53 0 0½	260 28	5 59	1 8 05
36	38 3 10	219 12	6 64	1 11 84
37	37 6 7½	206 24	7 13	2 1 59
38	37 4 7½	211 84	7 34	2 2 36
39	33 11 2½	189 04	6 70	1 11 93
40	32 15 11	186 52	7 60	2 3 17

Data Poultry Industry

For the above test an entry comprises 50 day-old pullets taken at random and reduced by random sampling at eight weeks old to 25 pullets. The test is for profitability over a period of 500 days, commencing from the date of hatching of each entry.

Egg production units are not only becoming larger but some producers have formed groups for the purpose of co-ordinating output and securing the benefits of bulk purchase of foodstuffs by the group, discounts on appliances, houses and other commodities. Some groups employ technical advisers.

The group system, long applied in the broiler industry, is now being extended in the egg industry, and experience in

broiler production suggests that the system will provide equally substantial advantages in egg production

The need for adopting every means of reducing production costs is imperative Competition for the consumer's custom is now keen and will become fiercer Moreover, the egg producer cannot rely on a continuance of the subsidy He must be prepared to produce eggs without the Government's price support

The following estimates of the capital required to equip poultry farms are based on average values of plant of good quality prevailing in 1960 Many costs are necessarily very variable, particularly those affected by farm lay out and situation

Much will depend on the system of poultry farming and the extent to which existing buildings may be adapted for egg and poultry production, for chick rearing and so on

The most economic method of starting a poultry project is to base it on an existing farm, that is to say, to establish a poultry section on a holding producing other livestock products and crops and which already provide a livelihood The poultry section can then be developed by stages until, perhaps, it becomes a major part of the farming activity

The prospective poultry farmer who must first purchase a suitable holding and then equip it will require substantial capital to day

It should be pointed out that capital expenditure is not necessarily related to profitability As a businessman the poultry-man is concerned with securing the highest return from his capital, thus he may find the battery system with a higher investment more profitable than the deep-litter or yard systems He is likely to do so if he is not skilled in stock management, for it is easier to secure a satisfactory return from birds housed in cages than in flocks, especially in large flocks

There is a tendency to measure profitability in terms of profit per bird This may be misleading

For example, if a battery plant shows a profit of 12*s* per bird and a deep litter plant 8*s* per bird, it would not necessarily follow that the former is the more profitable For the same capital sum it may be possible to keep twice the number of birds on deep litter as in single bird cages, hence the return per

unit of capital would be 12*s* from the battery, but 16*s* from the deep litter flock

On the hen-yard system it is possible, under favourable conditions, to house adult stock for as little as 2*s* or 3*s* per head, whereas on the battery system the cost of house and cages may exceed £2 per head for single-bird cages of "standard" 14–15 in width But cost can be substantially reduced to a sum in the region of 25*s* per head by housing two birds per cage or about 17*s* per head by housing three birds per cage Alternatively, saving of capital can be effected by installing narrower cages.

Large flocks can be housed on deep litter for between 25*s* and 30*s* per bird, at 3 sq ft floor area per bird.

But on many farms great economy may be effected by utilizing buildings no longer required for the purpose for which they were designed

Barns may be used for laying batteries or as deep-litter houses for laying stock, stables, lofts and even open-fronted hovels may be adapted at comparatively little cost for various classes of poultry including day-old chicks

Straw bales, straw and wire netting, roofing felt, galvanized sheets and home grown timber have their place in the construction of poultry-houses at low cost, so much so that by the judicious use of materials of this kind and existing buildings, it may be possible to provide accommodation for both young stock and adult birds at pre-war cost, or even below it.

However, the principal factors on which profits depend are the price of feeding-stuffs and the price of eggs and table poultry At present the poultry-man in a position to produce a considerable proportion of feeding-stuffs on his farm may reduce the cost of feeding by 10–15 per cent below the cost of ready mixed meals He can also lower costs by feeding grain balancer meals with home-grown or purchased grain

Capital Requirements

Breeding Farm The capital cost of equipping a breeding farm on conventional lines, *i e*, with small houses and grass runs, is high Although the difference in initial cost of this system and that of the intensive breeding house is not sub-

stantial, the former system entails much labour, and the cost of maintaining the fencing, especially in industrial areas, is high

Moreover, the advantages of intensive housing are now widely recognized Many of the most successful breeders keep their breeding flock in total confinement Prejudice against intensive housing is being overcome

However, if the range system is adopted estimated cost of equipping a small farm carrying about 1,000 head of breeding stock is shown in Table 48

It is suggested that tier brooders be used for initial brooding If the chicks are reared on the floor in groups of about 100–120 to four weeks of age, brooder-house sections should be approximately 8 ft × 8 ft

On this basis sixteen sections would be required with four spare sections by way of reserve accommodation A house 80 ft × 18 ft with a central passage would be suitable The approximate cost of the house with concrete floor and footings would be about £750, to which must be added the cost of twenty hovers (about £300) or twenty infra red units (about £90 with spares) together with cost of food and water troughs

TABLE 48

Estimated Cost of Equipping a Small Breeding Farm (about 1,000 Head of Breeding Stock)

	£
Food store and office	200
Incubator room (insulated concrete floor)	150
Cabinet incubator (setting capacity about 2 400 eggs weekly)	700
6 four tier brooders (400-chick capacity per brooder)	500
36 ft × 14 ft brooder house (insulated concrete floor)	200
25 Hay box brooders	260
25 Water troughs	25
25 Food troughs	30
60 Range shelters	1,200
60 Home made food troughs	45
30 Water troughs with ball valves	75
10 Portable solid floor houses (single-age flocks)	350
14 Portable solid floor houses (flock mating)	700
24 Home made food troughs	25
24 Water troughs with ball valves	60
Wire netting 52 rolls 6 ft × 2 in	170
Stakes and gates	[illegible]
Buckets food carrier and sundry equipment	[illegible]
	£4,970

The above estimate shows that housing the breeding stock on range in single sire and flock mated pens as indicated would cost about £1,450 for housing and fencing.

An intensive house about 126 ft × 25 ft for the same number of birds would cost about £1,800 including site preparation and concrete floor, and if fully insulated about £2,050–£2,100. Fan extraction would increase cost by about £150, but this would provide a substantial measure of control of environment.

The intensive house should be divided into sections by means of portable partitions. The breeder can then adjust flock size according to his requirements. The house should have a central corridor, from which eggs should be collected and from which the birds may be fed and watered.

Fold System. The capital required to equip a fold unit section of about 1,000 birds would be as follows:

TABLE 49

	£
50 Fold units (16 ft × 5 ft)	1,600
50 Bucket type drinkers	35
Portable food store	40
Hand truck	20
Food bins	30
Water carrier (50 gallon capacity)	20
Sundry equipment	10
	£1,755

The Laying Battery System. At one time most battery plants were equipped with single bird cages 14–15 in wide. To-day cage width varies from about 9 in to over 5 ft, cages of the latter width taking 10–12 birds.

Cages 14½ in wide are now commonly used for two or three birds, those 17 in wide for three or four. Very narrow cages are used for light hybrid pullets.

Assuming 14½ in cages in three tiers arranged in two blocks parallel to the length of the building are installed, estimated cost of plant is shown in Table 50.

Deep-litter System. The cost of deep litter houses of sound timber construction and fully equipped usually works out at 30s–35s per bird for flocks of about 1,000 birds housed at the rate of 3 sq ft per bird.

Cost can be reduced to approximately 20s per bird if floor

space allowance is lowered to 2 sq ft by having about one-third of the floor area occupied by a droppings pit with wire or slatted floor over it on which some of the food and water troughs should stand

Table 50

Housing 2,016 Birds in Twin bird Cages with Automatic Feeding

	£
House 120 ft × 18 ft	800
Preparation of site erection of house including water installation and electricity supply and concrete floor	300
1 008 Cages (scraper cleaned)	1 500
Food trolley	20
Sundries	20
	£2 640

The above estimates include foundations, but not the cost of road making, which in certain circumstances may add much to the overall cost of the plant

Table 51

Estimated Cost of Timber built Deep litter House for 1,000 Birds

	£
House 100 ft × 30 ft	850
Insulation	
Roof	150
Walls	60
8 Two-tier communal type nests	80
4 Water troughs with ball valves	24
24 8-ft food troughs with perches	100
Time switch	6
Wiring lamps, etc	100
Foundations water supply	400
Buckets and sundries	20
	£1 690

Insulation and fan extraction are now generally advised, nevertheless, houses thus equipped and complete with feeders, drinkers and nests are offered at £1,000 for 1,000 bird units (at 2 sq ft per bird), to which must be added the cost of foundations and expense involved in laying on water and electricity

It is impossible to estimate the cost of housing on deep litter in existing farm buildings, since in favourable circumstances little may be required other than food and water-troughs, nest boxes and artificial lighting A few shillings per bird may be sufficient to cover these costs

The handy-man will reduce costs by making nest-boxes, food-troughs and perches Cost of preparing site and constructing foundations is extremely variable

Cost of Rearing Pullets. The cost of rearing pullets is a matter of great importance to the commercial egg-producer and pullet rearer There is now a very extensive trade in growing pullets, some poultry-men catering almost exclusively for it Moreover, the egg producer should know the cost of rearing a pullet to maturity, for without this information he cannot assess the cost of egg production

Further, in certain circumstances he may find selling growing pullets more profitable than keeping them for laying Data with regard to rearing costs are presented in reports issued by the Agricultural Economics Departments of Universities and other sources undertaking agricultural economic surveys

TABLE 52

Average Cost of Rearing a Pullet to Point of Lay
(University of Nottingham, 1960)

	s	d
Day-old chick	3	5½
Foods		
Purchased	6	5
Home grown		3½
Labour		
Hired		9
Family		5
Dead stock depreciation and repairs		6
Miscellaneous		2
	12	0

The above data relate to the first year of the study, which began in October 1958

Costs varied from 9*s* 3*d* to 17*s* 10*d* per bird

"Part of this variation was probably due to differences between farms in size of the rearing unit, in the length of the rearing season and in the emphasis placed on hatching as opposed to commercial egg production

"In addition, the time taken to rear any given batch of chicks to point of lay varied from 18½ weeks (one producer rearing light hybrid birds) to 23 weeks (another producer rearing heavier birds)"

On average 10 per cent of the chicks purchased failed to survive.

The cost of rearing autumn- and spring-hatched pullets is under constant investigation in studies carried out at the National Institute of Poultry Husbandry.

Table 53 shows rearing costs in 1955–56.

The value of hatching a proportion of the pullet replacement stock in November and December is discussed on page 305.

TABLE 53

Cost of Rearing Pullets 1955–56—*Pence per Bird Based on Survivors Data from the National Institute of Poultry Husbandry*

	To 8 weeks	To 12 weeks	To 16 weeks	To 19 weeks
December hatched				
Chick	31.0	31.5	31.5	31.5
Food	19.5 (5.2 lb.)	39.1 (10.7 lb.)	56.7 (16.2 lb.)	75.5 (22.1 lb.)
Litter	0.7	1.2	1.8	2.2
Fuel	4.2	4.3	4.3	4.3
Labour	6.1 (11.1 min.)	9.1 (16.3 min.)	10.5 (18.8 min.)	11.9 (21.2 min.)
Depreciation	3.4	5.0	6.3	7.3
Total	64.9	90.2	111.1	132.7
	To 8 weeks	**To 12 weeks**	**To 16 weeks**	**To 20 weeks**
April hatched				
Chick	44.7	45.3	45.3	15.4
Food	16.1 (4.4 lb.)	33.4 (8.9 lb.)	55.2 (15.2 lb.)	75.5 (21.1 lb.)
Litter	0.4	1.0	1.0	1.0
Fuel	1.5	1.5	1.5	1.5
Labour	3.8 (6.6 min.)	4.9 (8.6 min.)	6.0 (10.4 min.)	7.4 (12.9 min.)
Depreciation	3.0	4.2	5.4	6.7
Total	69.5	90.3	114.4	137.5

No. Birds: December hatched, 192
April hatched, 343

Breed Cross: White Leghorn × Buff Rock

Housing—Intensive Rearing: Chicks were floor brooded on peat moss litter to eight weeks of age, and were then housed as one flock in a solid floor intensive rearing house on deep litter.

Feeding: Dry chick mash *ad lib.*, with a limited amount of chick crumbs or pellets twice a day. After eight weeks of age, growers' *grain balancer mash dry ad lib.*, with supplementary feeds of wheat from 8 weeks to point of lay.

Mortality: To nineteen weeks (Autumn hatched)—3.5%
To twenty weeks (*Spring hatched*)—8.5%

Body Weights (average weight): Autumn hatched at nineteen weeks old 66.3 oz.
Spring hatched at twenty weeks old 62.6 oz.

Early hatched birds have always been profitable. They are particularly suitable where intensive conditions and artificial lighting can be provided during the winter months.

Temperton (1952) pointed out that at the National Institute of Poultry Husbandry about 40 per cent of the replacement stock is hatched in November and December and the remainder in March and April. The autumn-hatched pullets come into lay in April and May; artificial lighting is used in the early autumn, beginning in August with a period of $\frac{1}{2}$–$\frac{3}{4}$ hour daily and gradually increasing the hours of lighting as the days shorten. The flock is sold in February or March of the following year.

It will be understood that the cost of rearing, and of course the cost of egg production, are affected to a great extent by mortality. Abnormal mortality may turn prospective profit into actual loss.

Every poultry-man finds that some groups of chicks fail to do well, and he must make adequate provision for them in his financial calculations. Similarly, every poultry-man finds that some years are more successful than others.

But the average loss in rearing should not exceed 5 per cent to eight weeks of age, 5 per cent from eight weeks to maturity.

Cost of Egg Production. Many poultry management surveys are carried out by University Agricultural Departments, and the reader is advised to obtain copies of the latest reports.

These reports reveal one common factor—namely, the very wide difference in the financial results obtained on different farms, even on those farms employing the same system.

The report issued by the University College of Wales (1958–59) showed that returns from deep-litter flocks varied from a profit of 24*s*. 6*d*. per bird to a loss of 18*s*. 10*d*.; on the battery system profit varied from 15*s*. 11*d*. to 7*s*. 4*d*. per bird, while where these two systems were in use on the same farms profit range was from 16*s*. 2*d*. to 5*s*. 3*d*. per bird.

A study of the cost of egg production carried out by the University of Leeds, 1958–59, showed the following margins and egg yields per bird. Calculated profits at given levels of total cost and yield per bird are also shown.

TABLE 54

Cost of Producing Eggs: Margin and Egg Yield per Bird
(University of Leeds, 1958–59)

Margin per Bird

Loss			Profit				
30s.–20s.	20s.–10s.	10s.–0	0–10s.	10s.–20s.	20s.–30s.	30s.–40s.	
2	7	10	18	13	2	1	53

Yield per Bird

Less than 120 eggs	120–140 eggs	140–160 eggs	160–180 eggs	180–200 eggs	200–220 eggs	220–240 eggs	
2	4	4	8	10	15	10	53

Calculated Profits at Given Levels of Total Cost and Yield (per Bird)

Cost per bird (shillings)	Yield per bird (eggs)				
	150	170	190	210	230
		Profit in shillings			
30	+15·2	+21·3	+27·5	+33·7	+39·8
40	+ 4·5	+10·6	+16·8	+23·0	+29·1
50	− 6·2	− 0·1	+ 6·1	+12·3	+18·4
60	−16·9	−10·8	− 4·6	+ 1·6	+ 7·7
70	−27·6	−21·5	−15·3	− 9·2	− 3·0

"Birds which cost no more than 40s. to keep were profitable even before they produced 150 eggs per year, but at 60s. per bird it was necessary to have a yield of at least 210 eggs a year to break even."

In view of the price emphasis on the autumn–winter egg, it is obvious that, other factors being equal, the higher the winter egg production the greater the profit. For this reason intensive methods with artificial lighting are now generally favoured, since it is usually difficult, if not impossible, to provide the best environment for high winter egg production where extensive systems are employed. Weather conditions have little effect on egg production where the birds are kept on one of the intensive systems, whereas a spell of severe weather, especially when accompanied by snow, may cause a serious slump in output if they are kept on range.

The guaranteed egg price is determined by the Annual Price Review held in accordance with the Agriculture Act 1947

The price is that guaranteed to the British Egg Marketing Board—not to producers It is subject to deduction of cost of the Board's services, which in 1959–60 amounted to 4 095*d* per dozen

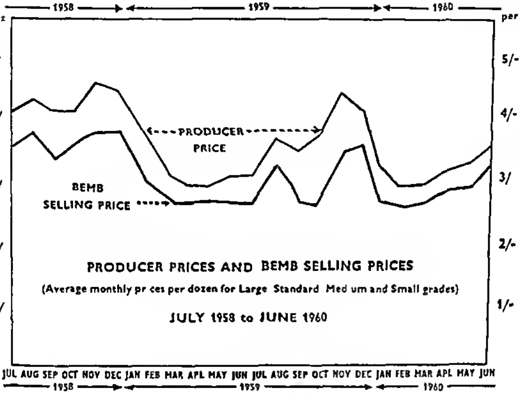

FIG 294 —AVERAGE EGG PRICES, JULY 1958/JUNE 1960
Reproduced by courtesy British Egg Marketing Board Annual Report 1960

Note to Fig 294 For the period March 31 1960 to March 30 1961 the guaranteed price for hen eggs (average per dozen) was 3*s* 11 15*d* and was related to a basic poultry feed price of 26*s* 5*d* per cwt for a standard ration composed of —

Feeding wheat	20%	Wheat offals	20%
„ barley	10%	White Fish Meal	5%
„ oats	20%	Extracted Soya bean meal	10%
Maize	15%		

For each complete change of 7*d* per cwt in the price of this standard feed ration a corresponding change of ½*d* per dozen is made in the guaranteed price of eggs

The flat rate of subsidy in 1960–61 was estimated at 11 35*d* per dozen eggs delivered to wholesalers at an average selling price of 2*s* 11 8*d* per dozen

The rate of subsidy is subject to adjustment under revised

For example, when pullets are kept in single-bird cages with static feeding and individual production is recorded, probably about 2,500 birds would be sufficient for one man to look after during normal working hours

With mechanized twin-bird cages he would manage about twice this number if a system of block recording was adopted, i e, egg production was recorded from blocks of cages, not individual cages

There are battery plants of some 2,400 birds in twin-bird cages in which daily routine feeding, egg collection and cleaning (excluding cleaning manure pits or trays and carting away the manure) is completed in about five hours, there are others in which all routine work for about 6,000 birds (three birds per cage) is undertaken by a man with the assistance of two girls

Labour cost of recording individual birds in cages is high, and it is for this reason that few undertake the work or record only for short periods at certain seasons

Labour required for management on range may be extremely low where the birds are kept in large flocks or closely grouped smaller flocks when steps are taken to save labour in feeding and watering

On the contrary, small flocks widely scattered about the farm will require much labour to look after them

Reference has been made to the importance of laying on water to the houses and to convenient parts of the farm It will effect a great economy of labour

Progressive producers are saving labour in handling feeding-stuffs Bulk delivery is becoming more popular It saves the cost of filling sacks and the weight of food represented by the sack, because food in sacks is sold on the basis of gross weight (including sack), it saves time and waste of food

Feeding-stuffs are delivered in bulk-feed lorries The containers on the lorries are connected by large-diameter flexible pipes to the inlet ducts of the granary or food-storage bins They are then filled pneumatically from the lorries Some systems of bulk delivery employ gravity for discharge On many farms feeding stuffs are carried from lorries to bulk storage bins by mechanical conveyors of the auger or belt type The former are most widely used on poultry farms

Bulk-feed hoppers are now installed in some of the larger

houses, while outdoor storage hoppers at suitable points on the farm save time in feeding stock on range. These hoppers are, of course, filled from the bulk-delivery lorries.

Second-year Birds. Main advantage in retaining a proportion of laying stock for a second season is that livestock depreciation is spread over two years instead of one, since there is little difference between the market value of pullets at the end of the first laying season and hens. There is also economy in rearing equipment, because the number of replacement pullets required is smaller.

Assuming mortality among pullets and hens is similar and that the initial value of the point-of-lay pullet is estimated at £1 1*s.* and the value of the hen at 9*s.*, the difference in depreciation between the pullet and hen is 12*s.* or forty-one eggs at 3*s.* 6*d.* a dozen.

Pullets laying 200 eggs in their first season should lay about 150 in their second, but the difference in egg production between the two classes of stock occurs while hens are moulting, and it is at this time that egg prices are high.

During the ten-week period hens are out of lay, pullets should produce about forty-two eggs per head (60 per cent production) which at 4*s.* a dozen (winter price) represents a gross return of 14*s.* This will meet the depreciation charge against the pullet and leave a credit balance of 2*s.*

If the initial value of the point-of-lay pullet is assessed at cost of rearing, then, of course, the difference between the profitability of pullets and hens becomes proportionately greater.

There is no doubt that selected second-year birds are profitable layers, but at prevailing prices pullets are usually more profitable. Price changes and a premium on large eggs may warrant retaining a proportion of the birds for a second year, but at present a good case can be made out for the all-pullet flock.

That the retention of laying stock for two years may yield additional profit is shown in Table 55.

Should the producer decide to keep some of his birds for a second year, they should be carefully selected, only those showing the characters associated with the high producer being retained. These birds should be force-moulted in late July or early in August, and placed under artificial light during the autumn and winter months. Artificial lighting should be

regarded as essential for this class of stock It may be more profitable to sell these birds in the following spring, rather than retain them for summer laying

TABLE 55
A Comparison of Flocks of Yearling Hens and Pullets on Deep Litter (Edinburgh School of Agriculture Economic Report, 1957–58)

Costs and returns per bird	Pullet flocks (12 flocks 4 053 birds)	Flocks of yearling hens (2 flocks, 167 birds)
Food costs	£ s d	£ s d
Purchased	1 8 5	1 3 7
Home grown	2 8	5 0
Total net food costs	£1 11 1	£1 8 7
Labour	6 5	5 6
Other costs	2 11	3 0
Housing and equipment depreciation	2 1	1 3
Flock depreciation	9 1	3
Total net costs	£2 11 7	£1 18 7
Total receipts	£3 7 4	£2 15 8
PROFIT	15 9	17 1
General data		
Average egg yield	199	152
Price per dozen eggs sold	4s 0½d	4s 4¾d
% mortality	9%	7½%
% culling	30%	13%
Weight of concentrates per bird per year		
Purchased	103 6 lb	83 4 lb
Home grown	13 44 lb	24 6 lb
Total weight of concentrates	117 04 lb	108 lb
Cost of concentrates per cwt	29s 3d	29s 1d

Although yearling hens produced 1s 4d per bird greater profit than pullets, this was due entirely to lower costs

The report points out, however, that —

" in general the total profit earned by a flock of pullets will tend to be greater than that earned by the same flock in its second year of production This is due to the reduction in the total flock size which results from culling and mortality during the first year's production

"For example, on the basis of the data shown in the Table, if the average size of the pullet flock at the start of lay is 1,000 pullets, then after a year's production with average mortality the flock size would be reduced to 610 hens. If the culling and mortality have been at regular intervals, the average size would be 805 hens and the total profit £634.

"Similarly, the yearling flock with an average size of 610 hens at the start of lay would be reduced in size to 485 hens after a year's production, have an average size of 547 hens and earn a profit of £467 only. Thus the flock would earn £167 more as pullets than it would as yearling hens."

Disposal of Pullets. In commercial practice egg production should follow a definite plan, which should be modified only in exceptional circumstances. The rearing programme should be in accordance with it. Thus the plant will be kept as fully occupied as practicable, and therefore maximum returns from the invested capital should be assured.

The disposal of pullets is no longer influenced to an appreciable degree by the prevailing prices of eggs and table birds. Most producers now follow a time schedule which provides little room for manœuvre. Pullets must be marketed when they have completed the laying season allotted to them; they must be sold to make room for others approaching maturity.

TABLE 56

Egg Yields and Variable Costs for Open Range or Semi-intensive, Deep-litter and Battery Systems (Edinburgh School of Agriculture, 1957–58)

Months of production	Flocks on open range or semi-intensive.	Flocks on deep litter.	Flocks in batteries.
11th month of production	Eggs	Eggs	Eggs
Yield per month .	17·5	14·4	18·6
Yield necessary to cover "variable" costs . . .	9·5	10·7	13·8
12th month of production			
Yield per month . .	13·0	12·8	14·0
Yield necessary to cover "variable" costs . .	8·4	9·8	12·3

The level of egg production may influence time of marketing, because should it fall below the line of profitability towards the end of the season, then obviously no useful purpose would be served in retaining birds that in any event would be sold in the course of a few weeks

Each flock should be sold as a unit, preferably in one consignment Arrangements for marketing should be made well in advance to avoid possible glut, and consequently lower prices

TABLE 57

Egg Numbers per Month Necessary to Cover "Variable" Costs per Hen at Varying Prices of Feeding stuffs and Selling Prices per Dozen Eggs Laid for the Three Groups Studied (Edinburgh School of Agriculture, 1957–58)

Prices per dozen eggs	Cost per cwt of food mixture	Number of eggs to cover "variable" costs		
		Open range plus semi intensive	*Deep litter*	*Hen batteries*
s d	*s*			
5 6	25	6·4	6·6	7·5
	30	7·3	7·6	8·5
	35	8·2	8·6	9·5
	40	9·1	9·6	10·6
5 0	25	7·0	7·3	8·2
	30	8·0	8·4	9·4
	35	9·1	9·5	10·5
	40	10·1	10·6	11·7
4 6	25	7·8	8·1	9·1
	30	8·9	9·3	10·4
	35	10·1	10·5	11·7
	40	11·2	11·7	13·0
4 0	25	8·7	9·1	10·2
	30	10·0	10·5	11·7
	35	11·3	11·8	13·2
	40	12·6	13·2	14·7
3 6	25	10·0	10·4	11·7
	30	11·5	11·9	13·4
	35	12·9	13·5	15·1
	40	14·4	15·1	16·7
3 0	25	11·7	12·1	13·7
	30	13·4	13·9	15·6
	35	15·1	15·7	17·6
	40	16·8	17·5	19·6

Producers should discuss their poultry marketing problems with representatives of local processing stations or others in a position to handle birds in bulk

As the end of the laying season approaches the flock should be carefully watched for signs of widespread moulting Birds should be marketed before it becomes general Moulting results in depreciation in market value of the birds, moreover, if the flock is retained until many of the birds are moulting the consequent drop in egg production will be reflected in lower profit for the year

TABLE 58

Cost of Egg Production in Plough cleaned Laying Batteries (National Institute of Poultry Husbandry, 1956–57)

Initial number of birds 504 period 48 weeks

Eggs per cage	197 3
Percentage production	59
Eggs first 24 weeks	103 6
Percentage cracked and soft shelled eggs	3 7
Percentage mortality	12 3
Labour per cage minutes per week	2 9
Food per cage lb per week	1 9
Lb food per dozen eggs	5 6
Total cost per cage	57s 4d
Total income per cage	65s 3¾d
Net profit per cage	7s 11¾d
Total cost per dozen eggs	3s 5½d
Total income per dozen eggs	3s 11¼d
Net profit per dozen eggs	5¾d
Cost of food per cwt	35s 3½d
Eggs to buy 1 cwt of food	106 6
Eggs to cover cost per cage	173

Average egg yield per hen for the eleventh and twelfth months of the production year and yield necessary to cover variable costs, which include food, labour and sundry expenses, are shown in Table 56

Table 57 shows the number eggs required per month to cover variable costs per hen at varying feed and egg prices

Egg Production in Batteries Capital cost of equipping a battery plant on a bird housed basis has been substantially reduced, largely on account of the introduction of the multi bird cage and the reduction in size of the single bird cage

The battery system has lost none of its popularity, indeed,

large plants continue to be established on farms up and down the country

Is the system the most profitable? This is an everyday question. Results of economic surveys are inconsistent This

TABLE 59

Average Costs and Returns from Laying Battery Flock (University of Durham)—Period September 1, 1958–August 31, 1959 [1]

PER BIRD

Costs	Lb	£ s d	£ s d
A Foods			
(a) *Purchased*—			
(1) Compounds	102	1 9 7	
(2) Cereals	—	—	
(3) Other	4	7	
(b) *Home grown*—			
(1) Cereals	3	9	
(2) Other	0	—	
Total foods	109		1 10 11
B Labour	Hr		
(*a*) Hired	1 4	4 3	
(*b*) Family	0 4	1 6	
Total labour	2 8		5 9
C Livestock depreciation		11 2	
D Deadstock depreciation and repairs		2 10	
E Miscellaneous		5	14 5
TOTAL COSTS			£2 11 1
Returns			
Eggs	Dozen		
(*a*) Market	17		2 14 2
(*b*) Hatching	—		—
(*c*) Used in farmhouse	—		1
TOTAL RETURNS			£2 14 3
Margin			3 2

PER DOZEN EGGS

	s	*d*
Total returns	3	2¼
Total costs	3	0
Margin		2¼

Number of flocks	21
Average size of flock, birds	595
Average length of flock season weeks	52
Average yield per bird, eggs	200

[1] W G R Weeks, University of Durham Personal communication

will be understood, because there are many variable factors at work Relative profitability of different systems vary from season to season at the same centre.

Tables 58, 59, 60 show costs and returns relating to battery egg production at the centres specified

TABLE 60

Flock Results of Laying Batteries (University of Reading, 1956–57)

	Costs—per dozen eggs	Costs—per bird week
	s d	*d*
Food	2 4	9 2
Labour	5	1 8
Bird depreciation	9	2 9
Dead stock depreciation	3	1 0
Miscellaneous	1	0 4
Total costs	3 10	15 3
Egg returns	4 2	16 9
Margin	4	1 6
Number of flocks		17
Egg yield per bird, week		3 9

Egg Production—Deep-Litter Flocks.

TABLE 61

Cost of Egg Production—Deep litter Housing and Conventional Feeding (National Institute of Poultry Husbandry, 1956–57)

Period 48 weeks, initial number of birds 298

Eggs per bird	183 9
Percentage production	55
Eggs first 24 weeks	100 8
Percentage mortality	8 4
Labour per bird minutes per week	1 6
Food per bird lb per week	1 9
Lb food per dozen eggs	5 9
Total cost per bird	47*s* 8½*d*
Total income per bird	58*s* 8¼*d*
Net profit per bird	10*s* 11¾*d*
Total cost per dozen eggs	3*s* 1½*d*
Total income per dozen eggs	3*s* 10*d*
Net profit per dozen eggs	8½*d*
Cost of food per cwt	28*s* 5½*d*
Eggs to buy 1 cwt of food	89 2
Eggs to cover cost per bird	149 5

Table 62 shows an average loss of 3*s* per bird, but returns varied from 24*s* 6*d* profit to 18*s* 10*d* loss per bird

If, however, the value of family labour and depreciation of

TABLE 62

Average Costs and Returns per Bird—Deep litter System
(University College of Wales, 1958–59)

	£	s	d
Foodstuffs			
Home grown		1	0
Purchased	1	15	0
Labour			
Family		8	2
Hired			1
Point of lay pullets			
Transferred in		10	5
Purchased		3	8
Depreciation of buildings and equipment		3	3
Poultry valuation difference		4	7
Other costs		2	5
Total Cost	£3	8	7
Current cost (cost less value of family labour and depreciation of buildings and equipment)	£2	15	5

	£	s	d	£	s	d
Eggs sold	2	17	1			
Used in house		1	7			
				2	18	8
Hens and culls					6	3
Poultry consumed in house						7
Other receipts						1
Total returns				£3	5	7

buildings and equipment is not charged average earnings are shown at 10s 2d per bird

Egg Production in Yards.

TABLE 63

Costs and Returns per Bird—Hen-yard System
(National Institute of Poultry Husbandry, 1955–57)

Year	1955 56	1956 57
Period	48 weeks	48 weeks
Initial number of pullets	230	250
Eggs per bird	142 8	175 2
Percentage production	42	51
Eggs first 24 weeks	85 6	92 2
Percentage mortality	11 7	12 0
Labour per bird minutes per week	1 6	1 9
Food per bird lb per week	1 7	1 8
Lb food per dozen eggs	7 0	5 8
Total cost per bird	48s 6d	48s 2½d
Total income per bird	47s 10¼d	56s 4¼d
Net profit per bird	Loss 7¾d	8s 1¾d
Total cost per dozen eggs	4s 1d	3s 3½d
Total income per dozen eggs	4s 0½d	3s 10¼d
Net profit per dozen eggs	Loss ½d	6¾d
Cost of food per cwt	31s 2½d	28s 9½d
Eggs to buy 1 cwt of food	93 1	89 4
Eggs to cover cost per bird	144 7	149 9
Type of diet	Home mixed mash + grain	Home mixed mash + grain

TABLE 64

Costs and Returns per Bird on a Free Range System
(University College of Wales, 1957–58)

	£ s d		£ s d	£ s d
Foodstuffs		Eggs		
Home grown	5 5	Sold	2 1 3	
Purchased	1 0 8	Used	2 2	
Family labour	4 6			2 3 5
Hired	3 9	*Hens and culls*		1 10
Point of lay pullet	10 0	Poultry consumed in house		1 2
Depreciation of buildings and equipment	10			
Poultry valuation difference	1 6			
Other costs	6			
Total costs	£2 7 2	Total returns		£2 6 5
		Loss		9

Egg Production on Free Range. While there has been a marked swing to intensive methods in recent years, range flocks can be a profitable side-line on the general farm, where they are managed largely by family labour Such flocks can be fed very cheaply indeed Profitability of these flocks depends on economy of feeding

TABLE 65

Costs of Egg Production—Birds in Colony Houses on Free Range
(National Institute of Poultry Husbandry, 1956–57)

Year Period Initial number	1956–57 48 weeks 323 yearlings	1956 57 48 weeks 325 pullets
Eggs per bird	75 5	132 4
Percentage production	22	39
Eggs first 24 weeks	32 1	68 0
Percentage mortality	17 0	13 5
Labour per bird minutes per week	2 2	2 4
Food per bird lb per week	1 6	1 8
Lb food per dozen eggs	12 1	7 9
Total cost per bird	27*s* 4½*d*	46*s* 7*d*
Total income per bird	24*s* 4½*d*	43*s* 5½*d*
Net loss per bird	3*s* 0*d*	3*s* 1½*d*
Total cost per dozen eggs	4*s* 4¼*d*	4*s* 2¾*d*
Total income per dozen eggs	3*s* 10½*d*	3*s* 11¼*d*
Net loss per dozen eggs	5¾*d*	3½*d*
Cost of food per cwt	29*s* 3*d*	29*s* 9*d*
Eggs to buy 1 cwt of food	90 6	90 7
Eggs to cover cost per bird	84 0	141 9

Up-to-date data with regard to costs of egg production from flocks on free range are meagre. When available the information frequently relates to small flocks.

The cost results of a study undertaken at the National Institute of Poultry Husbandry in 1956–57 are presented in Table 65.

Average costs of egg production per bird grouped according to the system of housing is shown in Table 66.

TABLE 66

Costs and Returns per Bird Under Four Systems of Management
(University of Nottingham, Year Ending September 30, 1959)

	Battery			Deep litter			Mixed			Free range		
	£	s	d	£	s	d	£	s	d	£	s	d
Total foods	1	9	3½	1	12	3	1	8	0	1	8	11
Total labour		6	5		7	3		5	1½		9	4½
Total other expenses		11	3		15	1		15	8		14	11½
Total costs	2	6	11½	2	14	7	2	8	9½	2	13	3
Total receipts	2	13	3	2	17	2	2	11	11½	2	11	9
Surplus		6	3½		2	7		3	2		—	
Loss		—			—			—			1	6
Average number of layers		702			728			746			447	
Average dozen eggs per layer		15			15			16			13	
Number of records		7			9			4			4	

Light Pattern. The effect of light pattern on growing pullets and their subsequent performance in the laying house is shown by work carried out at Reading University by Morris and Fox. Data presented in Table 67 relate to 600 pullets hatched December 4, 1957, and divided into two equal groups.

Economics of Poultry Breeding. Returns from poultry-breeding enterprises vary even more widely than do those from commercial egg production. The breeder who builds up a reputation as a supplier of high-quality stock, and especially if he is consistently among the top ten competitors in the laying trials, can secure an income far in excess of that obtainable from table-egg production. He can, in fact, make his fortune.

But, it must be emphasized, fortunes in poultry breeding are made only by exceptionally skilled men richly endowed with business attributes.

For the man with foresight, sound judgment and, it should be

Table 67

Economic Data Relating to Light Pattern (*Morris and Fox*, 1959)[1]

Rearing

Controls—natural daylight

Lighted—natural daylight and artificial light to provide day length of 24 hours in the first week declining weekly and uniformly (by 35 minutes) until natural day length only at 17 weeks of age

Housing

Laying cages at 17 weeks of age Two birds per cage, except for 60 pullets of each treatment which were housed singly

Lighting

Natural light to July 1, thereafter a 17 hour day for all birds

Average Egg Grading

	Age, weeks				
	17–25	25–33	33–45	45–65	17–65
			Per cent		
Controls					
Large	7.1	4.3	19.0	63.0	29.7
Standard	9.2	40.2	66.6	35.4	43.2
Medium	47.1	47.9	13.6	1.4	20.8
Small	36.6	7.6	0.8	0.2	6.3
Lighted					
Large	7.7	8.1	32.7	77.4	43.5
Standard	25.3	62.2	60.1	21.8	43.5
Medium	55.5	28.1	6.5	0.6	11.7
Small	11.5	1.6	0.7	0.2	1.3

Estimated Profitability	Controls	Lighted
Average eggs per pullet housed	147.5	163.0
" price per dozen eggs	46.9*d*	49.3*d*
" egg income per pullet housed	48*s* 0*d*	55*s* 10*d*
Estimated food consumption per pullet housed	93.8 lb	100.4 lb
Cost of food per bird at £32 per ton	26*s* 10*d*	28*s* 8*d*
Average liveweight at 65 weeks	6.63 lb	7.40 lb
Percentage survivors at 65 weeks	86.0	87.6
Average carcase value per pullet housed at 1*s* 6*d* per lb liveweight	8*s* 7*d*	9*s* 9*d*
Margins (Eggs + Carcase − Food) per pullet housed	29*s* 9*d*	36*s* 11*d*
Difference (Lighted − Controls)	7*s* 2*d*	

[1] *British Poultry Science*, Vol 1, p 25

added, ability to accept risks, money can be made from breeding, from chick production (hatcheries) and other branches of the industry, as it can in other industries.

So far as the writer is aware, the only economic report dealing specifically with accredited poultry-breeding enterprises is that published by the University College of Wales

In this report flocks are classified according to the percentage of eggs sold for hatching or used for home hatching. Group B

includes those farms which sold for hatching more than one-third of the total eggs produced

Taking this group as an example, the average costs and returns are presented in Table 68

TABLE 68

Average Costs and Returns per Bird—Accredited Breeding Flocks, Group B (University College of Wales, 1958–59)

	£	s	d		£	s	d
Foods				Market eggs sold	1	4	9
Home grown		2	10	Hatching eggs	2	4	0
Purchased	2	4	3	Hatching eggs used on farm			7
Labour				Eggs consumed in house		1	7
Family		11	5				
Hired		—	—	Total return from eggs	£3	10	11
Hatching eggs (home produced)			7	Growing and mature stock sold			2
Cocks, pullets and chicks purchased		2	11	Table poultry, hens and culls sold		8	10
Depreciation of buildings and equipment		1	11	Poultry consumed in house			8
Poultry valuation difference		2	8	Total returns from poultry		9	8
Other costs		1	4	Other returns			5
Total costs	£3	7	11	Total returns	£4	1	0

Table-poultry Production. Table poultry production is very speculative Prices may fluctuate markedly from year to year and from season to season. Birds of inferior quality are unprofitable, moreover, if they are packed with others of first quality the whole consignment will be down graded which, of course, will be reflected in the price returned to the producer.

It is essential to adopt specialist methods if table-poultry production is to leave a worthwhile profit or even any profit This does not imply that production must be undertaken on a full-time basis; a well-managed plant operated as a side-line can prove financially successful, particularly for the poultry-man who has a private trade with consumers or retailers

Many poultry-men principally concerned with egg production and/or breeding have found a profitable outlet for cockerels and culled hens with consumers and local poulterers Some have developed a farm-gate trade, and they have catered for it by installing a small plucking machine and deep freeze storage cabinet Thus oven-ready birds are handed to customers calling at the farm

But table-poultry production is becoming more and more the work of specialists operating on a large scale, and it will be increasingly difficult for small producers catering for wholesale markets requiring chickens of popular broiler weight (about $3\frac{1}{2}$–4 lb) to compete with them

No one should invest capital in this branch of the poultry industry before giving due consideration to the many factors involved It is especially important to study the requirements of buyers, to find a market and then set out to cater for it Today marketing presents bigger problems than production

Processing—killing, plucking, dressing and packing—has also become the work of specialists Few commercial producers undertake it unless their output is sufficiently large to warrant employment of the necessary staff and equipment

Principal factors affecting cost of table-poultry production are feed cost and feed-conversion ratio (*i e*, number of lb feed required to produce 1 lb liveweight gain) cost of chick, the percentage mortality and the cost of labour, fuel and depreciation of plant

Food is by far the largest item, representing about 55–60 per cent of total costs in small-scale production and 65–70 per cent when mass-production methods are employed

As in egg production, all factors are important The producer cannot afford to disregard any of them He must buy chicks of superior quality (preferably of table strains) and feeding-stuffs showing a narrow feed-conversion ratio He must have an efficient plant under competent management

Cost of erecting a table-poultry (broiler) plant is variable *On some holdings farm buildings have been converted success*fully to broiler production at extremely low cost As a rule, however, purpose-built houses are employed

Efficient housing is essential, modern standards must be applied, any attempt to lower them for the purpose of reducing capital expenditure will be reflected in lower average profitability from a project of this kind in which even under the best housing conditions profit per bird is low

Cost of a well-built broiler house, fully equipped, usually works out at about 10*s*–11*s* per sq ft floor area This sum is

exclusive of cost of the site and expenditure that may be necessary for the construction of approach roads

Estimated cost of a 10,000-bird unit is shown in Table 69

TABLE 69

Estimated Cost of a 10,000 bird Broiler Plant, 1960

	£	s	d
House 200 ft × 40 ft (fully insulated) providing 0 8 sq ft floor area per bird, plus 10 ft food storage bay	2 300	0	0
Preparation of site footings and concrete floor	800	0	0
Electric light and power points	100	0	0
Time switch	5	10	0
Track and food trolley	120	0	0
Ten 1,000 chick capacity brooders	400	0	0
300 Tube feeders (approx 35 lb capacity per feeder)	450	0	0
Thirty 6 ft water troughs	160	0	0
Ten 18-in diameter fans (with fittings)	350	0	0
	£4 685	10	0

Broiler Costs and Returns. Broiler costs and returns are very variable Some broiler crops show a loss, even on well-managed plants An outbreak of disease or mishap in management may result in the chicks realizing prices below cost of production

Moreover, at certain seasons prices may be unremunerative These are risks inseparable from broiler production

Table 70 shows the results of four broiler crops by one well-known producer

TABLE 70

Summary of Results of Four Broiler Crops (1960)

Crop	1	2	3	4
No of birds sold	14 684	14 957	9 803	3 195
Mortality	3 61%	2 1%	0 4%	2 01%
Sex	As hatched	As hatched	As hatched	As hatched
Date sold	Jan 27–28	Apr 29	July 26	July 28
Age when sold days	71 72	72	68	70
Average liveweight lb	3 60	3 92	3 65	3 57
Average deadweight	3 17	3 43	3 19	3 12
Food conversion ratio live weight	2 66 1	2 56 1	2 36 1	2 48 1
Average cost food per ton	£40 7s 9d	£39 3s 0d	£40 3s 0d	£40 4s 0d
Food cost per bird	3s 5 2d	3s 6 0d	3s 1 27d	3s 2 28d
Sq ft per bird	1 0	0 99	0 97	0 89
Food cost per lb liveweight	11 37d	10 7d	10 21d	10 7d
Gross margin per bird	2s 4 5d	3s 2 5d	3s 0 23d	2s 9·9d
Gross margin per sq ft	2s 4 5d	3s 2 2d	3s 0 7d	3s 2 1d
Grading first quality	78 2%	92 2%	77 5%	85 6%

Data presented in Table 71 were provided by four producers. The figures represent average results from many crops.

TABLE 71

Broiler Costs and Returns (1960)

Producer	A	B	C.	D
Average cost of chicks per 100	£5 15s	£5 15s	£6	4·17d [1]
Age marketed, days	72	71	70	70
Percentage marketed	97·8	98·5	97–98	97
Average liveweight, lb	3·5	3·45	3·5–3·6	3·51
Food per lb liveweight / Food conversion ratio	2·5	2·55	2·6	2·65
Food cost per ton	£32 10s [2]	£39 10s	£39 8s	£38 14s
Food cost per chick	2s 6·6d	—	3s 2·0d	—
Food cost per lb liveweight	8·74d	10·5d	11·3d	11·02d
Cost per chick				
Labour	1d	3d	2·2d	0·8d [1]
Litter	½d	¼d	1d	0·10d [1]
Fuel and lighting	¾d	1¼d	2d	1·33d [1]
Medication	—	2d	0·05d	0·20d [1]
Overheads	2d	1·5d	1d	3·66d [1]
Total cost per lb liveweight	9·96d	1s 4d–1s 6d	1s 5·4d	1s 4·85d
Average wholesale selling price per lb live weight	1s 8d	1s 8½d–1s 9½d	1s 10d	1s 11·86d
Gross profit per lb liveweight	10·04d	—	5·3d	7·01d
Gross profit per bird	2s 11·14d	1s 2d–1s 10d	1s 6d	—

[1] Relative to cost per lb liveweight [2] Home mixed diets

Cramming. Cramming is rarely undertaken to-day, and it is doubtful whether the practice will be resumed, at least on an extensive scale.

In pre-war years it was not economic to employ a professional crammer unless he could handle some 500 or 600 birds more or less continuously.

However, assuming cramming is undertaken, cockerels should put on 12–16 oz. in ten days, and in this time they will consume approximately 3½ lb. of food at a cost of, say, 1s. 2d. per bird. Labour would cost about 3d. per bird if 600 birds are being crammed. The finish of the birds, however, will be improved

Capon Production. Cost of capon production was studied by Rowley at the *National Institute of Poultry Husbandry* (1956).

Three groups of (Indian Game × Light Sussex) × Light Sussex cockerels were used in this study. The chicks were hatched at weekly intervals as follows:—

Hatch 1	May 25	400 chicks	
„ 2	June 1	228	„
„ 3	„ 8	207	„

Chicks were reared extensively until 14 weeks old, when those of the first hatch were moved to strawyards each of approximately 1,000 sq. ft.

Two yards had an open-fronted shed with wire floor over droppings pits; the other two yards were wholly open and were furnished with uncovered perches.

At five weeks of age the birds in each hatch were divided into two groups, one group being surgically caponized at this age, birds comprising the other group were chemically caponized at 12 weeks from marketing and again 6 weeks later.

Capons not in yards were reared in shelters on grass range.

Home-compounded chick mash was fed *ad lib.* to 12 weeks of age, thereafter a home-compounded growers' grain balancer mash fed with approximately an equal weight of wheat. Flint grit was available at all times.

In the case of Hatch 1 the provision of a covered roosting section made no material difference to the final result, even though adverse weather conditions prevailed for long periods.

Results are summarized in Tables 72 and 73.

TABLE 72

Results per Surviving Bird from Hatching to Marketing—All Hatches

	Chemically caponized	Surgically caponized.
	s. d.	s. d.
Total returns	29 6¾	27 1¼
Production costs	21 9	20 9¾
Profit	7 9¾	6 3½
Percentage culls and deaths	11·7	12·0
Food, lb.	60·0	56·2
Labour, min	33·5	36·4
Body weight	8 lb 14·5 oz.	8 lb 4·1 oz

TABLE 73

Results per Lb Liveweight Sold at Christmas—All Hatches

	I	C
	s *d*	*s* *d*
Total returns	3 3¾	3 3½
Production costs	2 5¼	2 6¼
Profit	10½	9¼
Food lb	6 73	6 81

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D produced by irradiation of 7 dehydro-cholesterol may be more efficiently utilized by growing chicks and turkey poults than vitamin D from fish oils This difference in the efficacy of the vitamin D from fish oils and irradiated animal sterols is particularly apparent when the ration is low in inorganic phosphorus These factors have been considered in arriving at the recommended requirements for vitamin D, and the requirements listed are based on suggested minimum quantities of inorganic phosphorus With the suggested amount of inorganic phosphorus no difference in efficacy of vitamin D from fish oils and irradiated animal sterols should be observed in practice

[4] Requirements for vitamin E vary so much, depending on the nature of the diet, that it seemed inadvisable to include figures in the Table Chicks have been reared on purified diets very low in fat without any detectable vitamin E Vitamin E requirement is increased by high levels of unsaturated fats and decreased by the presence of antioxidants A part, but not all, of the biological function of vitamin E can be fulfilled by selenium

[5] This amount of calcium need not be incorporated in the mixed feed, inasmuch as calcium supplements fed free choice are considered as part of the ration

[6] At least 0 45 per cent of the total feed of starting chickens should be inorganic phosphorus All of the phosphorus of non plant feed ingredients is considered to be inorganic Approximately 30 per cent of the phosphorus of plant products is non phytin phosphorus and may be considered as part of the inorganic phosphorus required A portion of the phosphorus requirement of growing chickens and *laying and breeding hens must also be supplied in inorganic form* *For birds in* these categories the requirement for inorganic phosphorus is lower and not as well defined as for starting chickens

[7] Equivalent to 0 37 per cent of sodium chloride

The original report and revisions prior to 1954 all included margins of safety to compensate for possible losses of vitamins during the feed processing, transportation and storage, and for variations in feed composition and in environment These margins of safety, which were 66 per cent for vitamin A, 50 per cent for vitamin D and 20 per cent for the water-soluble vitamins, are not included in the present nutrient requirements

Example Chick mash (No 1, page 463)

	Protein	Calcium	Phosphorus	Fibre	Riboflavin, mg	Manganese, mg
15 lb Bran	2 25	0 016	0 18	1 35	20	810
30 lb Middlings	4 89	0 24	0 27	2 10	22	1,620
21 lb Yellow maize meal	1 80	0 002	0 06	0 42	12	42
15 lb Barley meal	1 50	0 075	0 05	0 75	8	105
6 lb Fish meal	3 60	0 300	0 21	—	24	108
6 lb Dried milk	2 10	0 072	0 05	—	54	—
5 lb Dried yeast	2 30	0 060	0 06	—	100	—
2 lb Limestone flour	—	0 780	—	—	—	—
½ lb Common salt	—	—	—	—	—	—
½ pt Cod liver oil	—	—	—	—	—	—
	18 44	1 329	0 88	4 62	240	2 685

Glossary of Poultry Terms

ADDLED. A fertile egg in which the embryo has died in the early stages of incubation.

ATAVISM. The resemblance of the progeny not to their parents but to their grandparents.

AUTOSOMES. Chromosomes other than the sex chromosomes.

BACK-CROSS. Mating of an F1 hybrid to one of the parents.

BARRED. Bands of colour across the feather, as in Barred Rock, North Holland Blue, etc.

BEARD. The feathers under the throat of certain breeds—*e.g.*, Faverolles, Houdans.

BEEFY. A large, coarse comb.

BRASSY. The yellow tinge in white fowls. Often seen on backs and shoulders, especially in cockerels. Sometimes called "weathering".

BROILER. A trade term denoting good quality table birds of about 3½–4 lb. liveweight, mass produced and marketed at 9–10 weeks of age.

CANDLING. Examination of the condition of shell eggs by passing a strong light through them. The work is done in a dark room or cubicle.

CAPONIZING. The removal of the testes.

CHEMICAL CAPONIZING. Administration of drugs having effects resembling those of surgical caponizing.

CHICK. This term usually refers to birds from day-old until removed from brooder or broody hen at six to eight weeks old.

CHALAZÆ. Dense coils of albumen attached to the yolk.

CHROMOSOMES. Minute thread-like bodies in the reproductive cells or gametes. Chromosomes are responsible for the transmission of characters to the progeny.

CLEAN-LEGGED. Legs free from feathers.

CLEARS. Infertile eggs removed from the incubators.

CLOUDY *or* MOSSY. Indistinct colour markings. No well-defined line between colours. Commonly seen in laced and pencilled varieties of fowls.

COBBY. Rounded, compact body-shape.

COCK. A male bird that has completed one breeding season.

COCKEREL. A male bird in its first breeding season.

CRAMMING. Forcible feeding.

CREST. A bunch of feathers on the head of certain breeds—*e.g.*, Houdan.

CROSS-BREEDING. The mating of two different breeds or two varieties of a breed.

CUCKOO Marking of the plumage very similar to barring
CUSHION A mass of soft feathers on the rump of the female Usually well developed in Cochins
CULL An unprofitable or unsuitable bird removed from the flock
DEAF EARS The ear lobes
DOMINANT Characters that appear in the first hybrid generation, when each parent shows one of two characters—*e g*, rose comb is dominant to single, " silver " to " gold "
DRAWING Removal of internal organs in preparing a bird for the oven
DRESSING Preparing bird for the oven
DUBBING Removal of cock's comb and wattles
F1 GENERATION The first filial generation, first generation of a specific mating
F2 GENERATION The progeny produced by mating the F1 generation
FANCIER A person who breeds stock for exhibition purposes
FEATHERED LEGS Feathers more or less covering the legs
FEATHER TRACTS The lines of feathers covering the body
FLIGHTS The large primary feathers of the wing
FLOCK MATING Mating a number of males with a flock in the same pen
FLUFF The soft feathers covering the abdomen
FRIZZLED A type of plumage in which the feathers are turned back as if frizzled or rubbed the wrong way
FURNISHED Fully feathered A cockerel having fully grown sickle and saddle hackle feathers is said to be " fully furnished "
GENES Hereditary factors carried by the chromosomes Genes are responsible for inherited characters Chromosomes transmit genes
GENOTYPE The genetical constitution for a character which may or may not be expressed
HACKLES The long, pointed feathers of the neck and, in the male, also of the saddle
HEN For the purpose of the Poultry Stock Improvement Plan a hen is a female bird not less than 18 months old
HEN HOUSED AVERAGE Average egg production based on number of birds originally housed
HENNY *or* HEN FEATHERED The absence of neck and saddle hackle feathers and sickles in the male—*e g*, Sebright bantam, Campine
HETEROSIS Hybrid vigour
HETEROZYGOUS A bird formed by the union of male and female germ cells which are unlike for a given character
HIGGLER A local term for a poultry dealer A man who buys eggs and poultry from farmers
HOCK The knee joint
HOMOZYGOUS When a bird is derived from the union of male and female germ cells, each containing a factor for a certain

character, it is said to be homozygous for that character. Such a bird will breed true for that character

Hopper A type of food-trough in which the food is replenished from a container above. The term is commonly applied to all types of feeding-troughs, whether or not they are of the self-fed type

Hover A heated canopy under which chicks are reared

Hump back A faulty spine. Commonly termed roach back. A serious defect, usually congenital

Hybrid Defined in P S I P Regulations as (a) The Hybrid must be produced by a programme of inbreeding or recurrent reciprocal selection, or (b) an incross or incrossbred must be achieved only with inbred lines of which the coefficient of inbreeding is not less than 50 per cent

In breeding Mating very closely related individuals—*e g*, father to daughter, mother to son. This is often referred to as "in and in breeding"

In cross Breeding Mating of highly inbred strains of different breeds

Incrossing Mating of highly inbred strains of the same breed

Intensive System A system of poultry-keeping in which the birds are totally confined to the house

Keel The breast bone

Lacing A stripe or edging round the feather of a different colour from that of the ground colour. It may be single, as in the Silver Wyandotte, or double, as in Indian Game

Leader A single spike at the back of the comb. In the Wyandotte it is short, and should follow the line of the neck. In the Hamburgh it is long, and follows the line of the comb base

Leaf comb A comb resembling a leaf as in the Houdan

Line breeding Breeding within the family or line. A form of in breeding that avoids the repeated use of closely related individuals

Mealy A term used to describe a defect in the plumage, especially of buff coloured birds, in which the feathers are more or less speckled with white

Miller's offals Bran and middlings or weatings

Mottled A white tip at the end of the feathers, as in Anconas. Also refers to black spots on the legs

Moult The shedding of the feathers and the growth of new plumage

Muffled The muff and beard of feathers at the side of the face, as in Faverolles, Houdans

Out breeding The mating of different strains of the same breed

Ped A crate used for marketing table poultry

Pellet Mash compressed into a solid mass of a size suitable for the particular age of stock. For adult birds the size is about that of a grain of wheat

PENCILLING Small stripes on the feather These may follow the outline of the feather or run across it

PETIT POUSSIN A chicken killed for table when weighing from ¾ to 1¼ lb (dead weight)

PHENOTYPE The appearance of an individual or its production record is termed its phenotype for the particular character

PLANT Houses, appliances and "dead stock" of the farm

PREPOTENT The ability of an individual to transmit characters to a marked degree The power to diminish or suppress the characters of the other parent in the progeny

PRIMARIES The ten large feathers of the wing, lying between the finger feathers at the wing tip and the small axial feather that lies between the primaries and secondaries

PULLET In utility A female bird in her first laying season N B —The Farming and Poultry Advertisement Control Board defines a pullet as a bird not more than twelve months old In the fancy a bird hatched on or after November 1st of the previous year

PULLET BRED In utility a term used to denote that the birds are bred from pullets In the fancy a bird bred from a pen of birds specially selected to produce exhibition pullets

REACHY A term denoting that the carriage of a bird is held well up

RECESSIVE Recessive characters are those that are suppressed in the first hybrid generation—*i e*, when a cross is made between two birds, *e g*, a bird pure for the rose comb factor will produce only rose combs in the first generation when mated to a bird having a single comb

ROACH BACK Hump back

ROSE COMB A broad comb with the surface covered with small nodules

SADDLE The part of the back about the tail in the male, equivalent in the female as the "cushion"

SAPPINESS A yellow tinge in birds having white plumage This arises from excessive pigment, and should not be confused with brassiness The latter occurs on the surface of the feathers while sappiness is also seen at the base of the feathers

SCALES The horny tissues covering the legs

SECONDARIES The set of quill feathers in the wing between the axial feather and the body

SELF COLOUR Plumage of one colour

SEMI INTENSIVE A system of housing in which the birds have access to a confined run

SHAFT The stem of the feather

SHAFTY When the shaft of the feather is easily seen on account of its being a lighter shade than the web

SHANK The part of the leg between the hock joint and the foot

SHEEN The gloss on the feathers

SIBS The progeny of brother sister matings

SICKLES. The long, curved feathers of the cock's tail.

SIDE SPRIGS. Fleshy nodules on the side of a single comb found towards the back of the comb. A serious [illegible] exhibition birds.

SINGLE COMB. A flat vertical comb with serrations along t[illegible]

SITTING. A number of eggs sufficient for one hen to cover.

SPIKES. The serrations on a single comb.

SPORT. When a new character appears unexpectedly in one generation and is transmitted to succeeding generations it is known as a "sport" or "mutation". The White Wyandotte originated as a "sport" of the Silver Wyandotte.

SPUR. The horn-like growth on the shank of the male bird.

SQUIRREL TAIL. The tail-feathers sloping forward—*i.e.*, towards the back. A serious defect.

STAG. A male bird. A term more commonly used with reference to game breeds and turkeys.

STRAIN. A group of birds constituting a family of one breed.

STUBBING. Removal of the short stub-feathers after plucking.

STUD MATING. Mating of individual hens or pullets (Single Penning).

SURREY FOWL. A trade term used to describe white-fleshed table-birds that have been crate-fed and perhaps crammed. The description is applied to table-birds of the best quality. It does not mean that the birds were produced in Surrey.

TELEOONY. This term is used with reference to the belief that a previous mating will influence the progeny of a later mating. For example, the belief that if a Light Sussex hen is first mated with a Rhode cockerel and subsequently with a Light Sussex cockerel, the Rhode cockerel will have some influence on the second mating. This belief is erroneous. The sperms fertilize the ova, and when the male bird is removed his influence is lost in the course of three or four weeks. A previous mating cannot influence later matings.

TOE-PUNCHING. Punching a small hole in the web of the foot for the purpose of identification.

TOP-CROSSING. Crossing highly inbred males with out-bred commercial stock.

TRUSSING. Tying a bird after plucking and drawing.

TYPE. Body conformation. Breed-type refers to the shape and size of the breed. A bird is said to be of good type when it closely conforms with the standard of the breed.

UNDER-COLOUR. The colour of the lower part of the feathers that is hidden by other feathers overlapping it, but which is exposed when the feathers are turned back.

UTILITY. Poultry bred for egg production and/or table purposes.

VARIETY. This term refers to the colour of birds of the same breed—*e.g.*, the Light, White, Speckled, Red and Brown Sussex are varieties of the same breed. Body-shape makes the breed, colour the variety.

WATTLES. The red, fleshy appendages hanging from the throat at the base of the beak.

WEB OF FEATHER. The barbs of the feather on each side of the shaft.

WRY TAIL. A tail not in line with the spine, but leaning to right or left. Due to a deformity which is usually heritable. No bird having this defect should be used for breeding purposes.

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